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Demystifying Computer Languages

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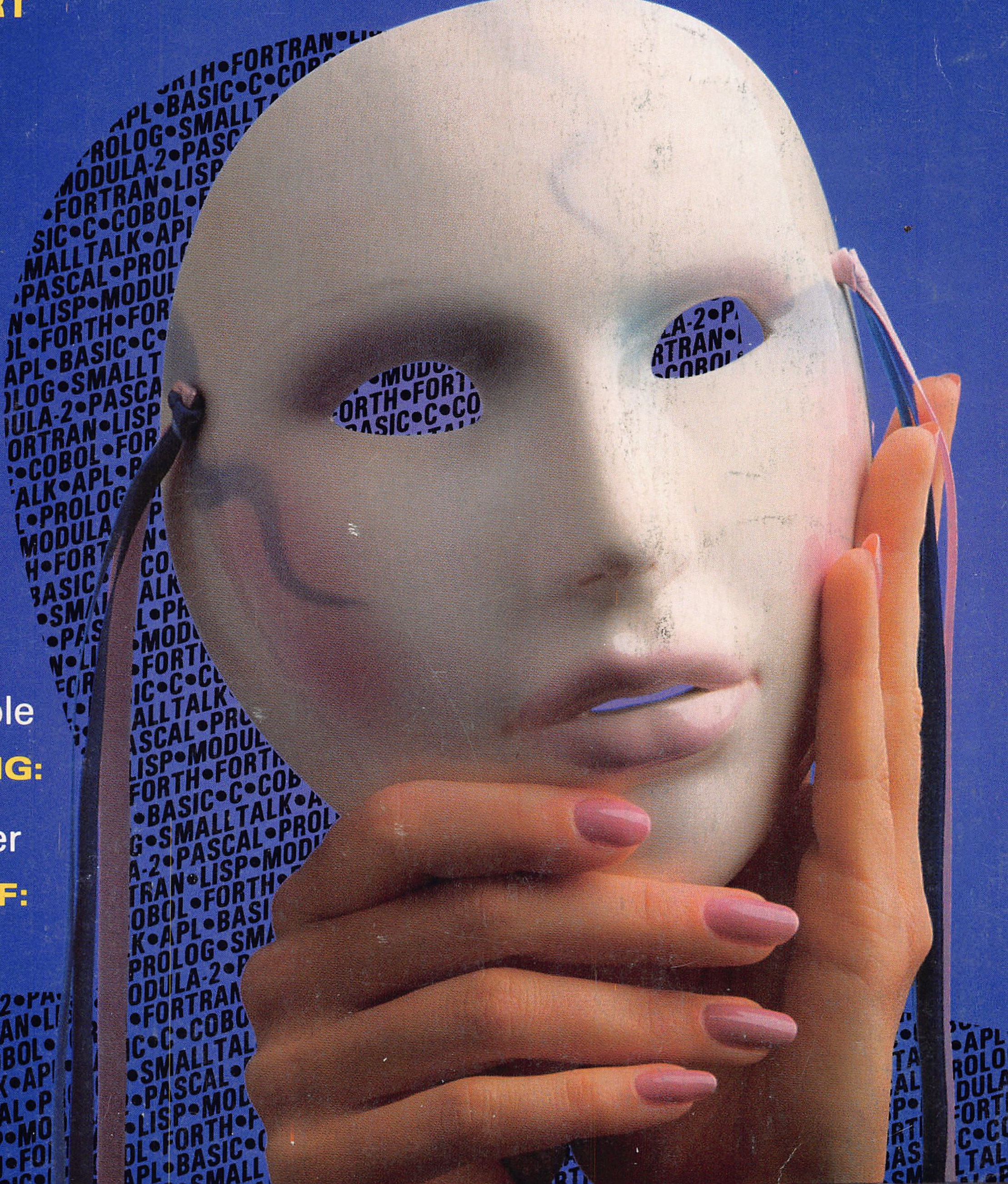
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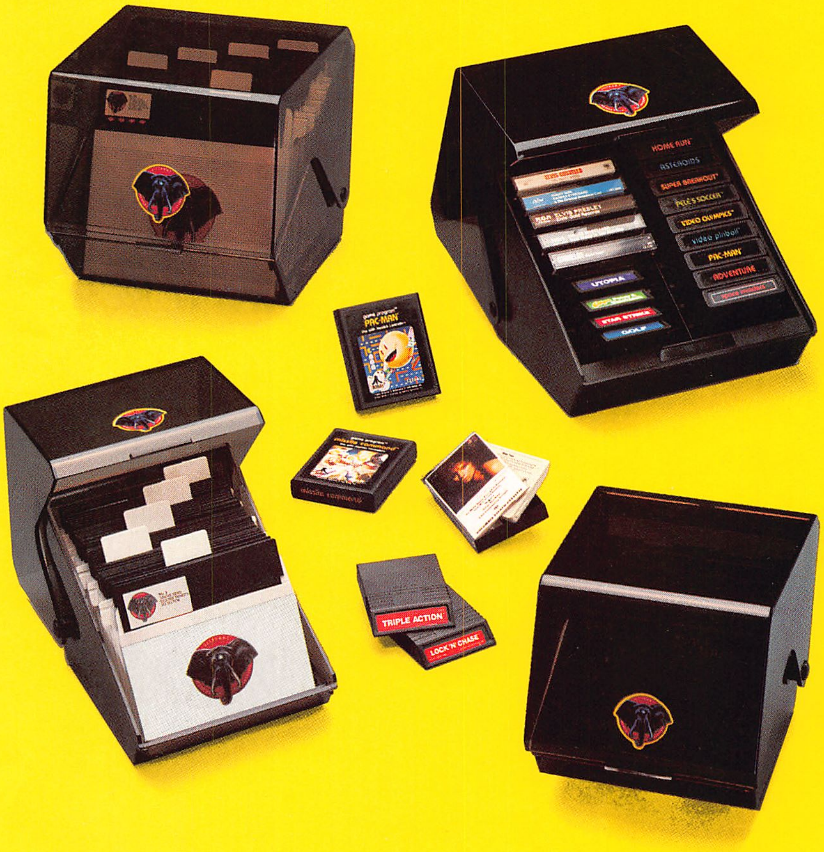
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Vol. 2, No. 11 September 1983

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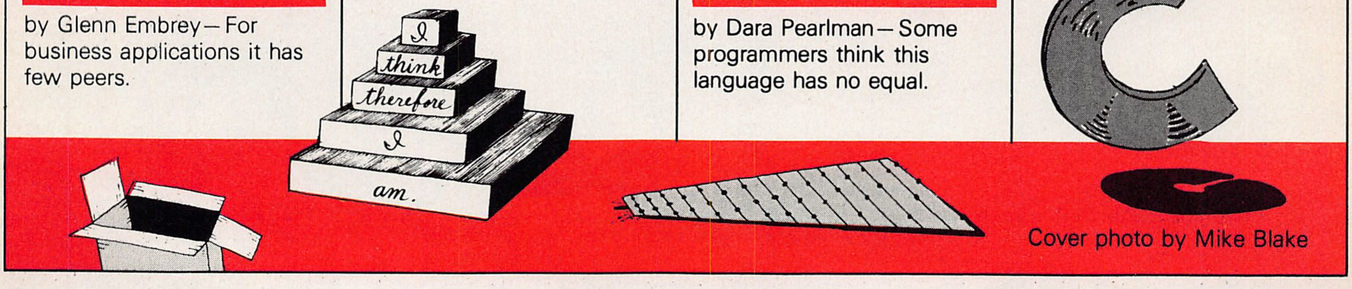

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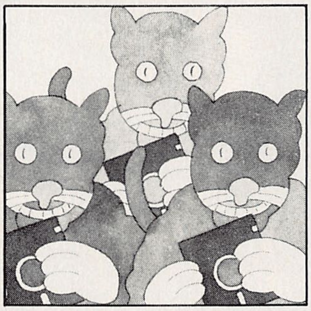

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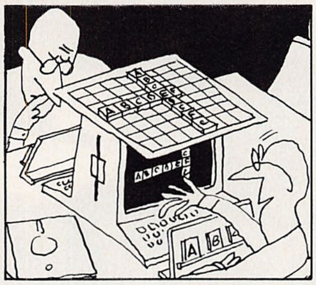

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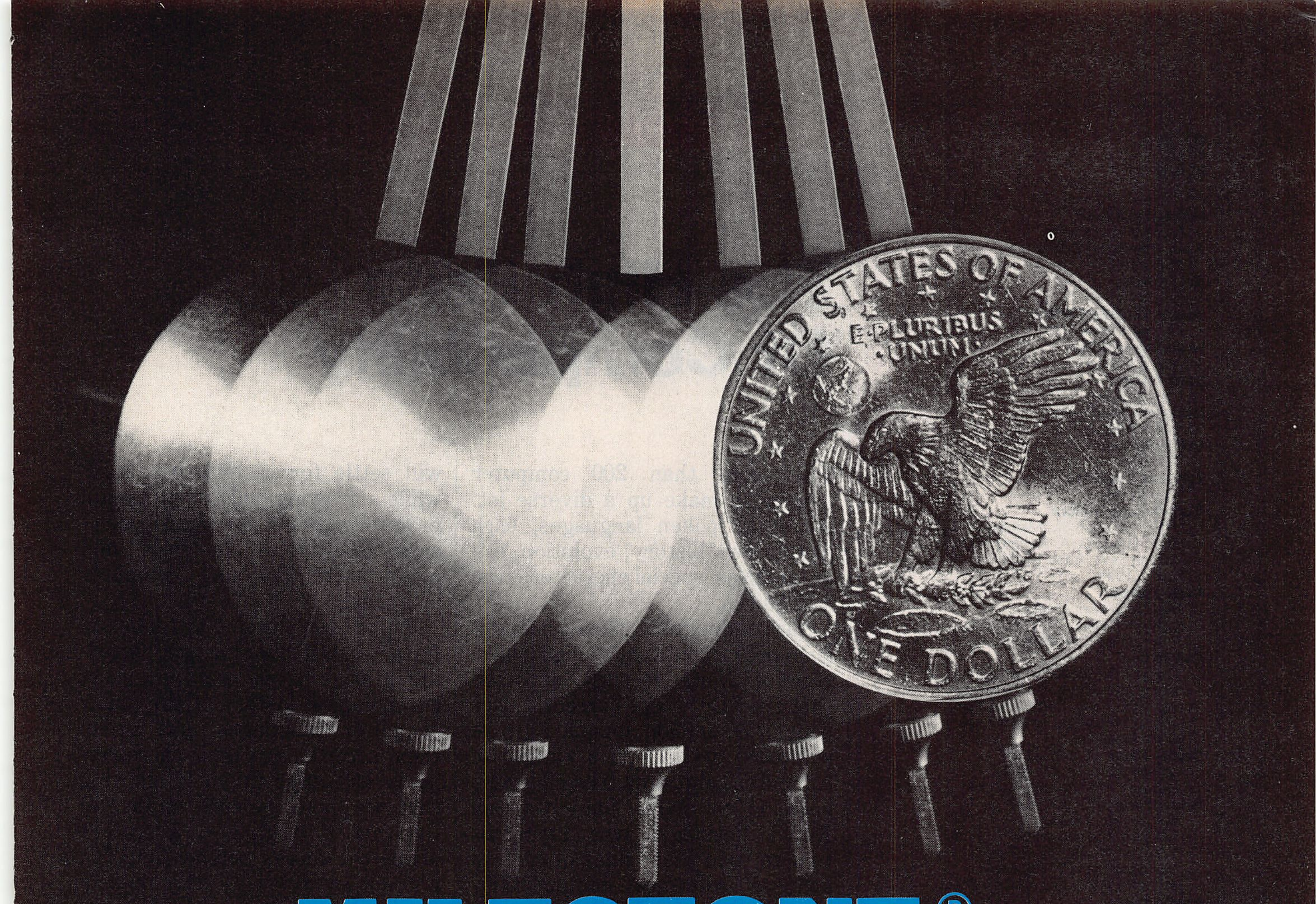

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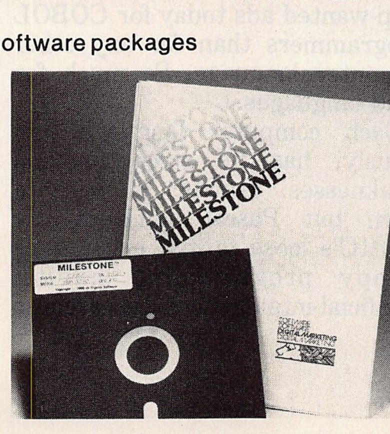

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POPULAR'S VIEW

The High Price Of Compatibility

The more than 200 computer languages make up a diverse lot. As with spoken languages, each has its own history, evolution, color, nuances, special characteristics, and quirks.

Such individuality has created a system compatibility nightmare. *Science News* recently reported that the U.S. Navy currently uses about "50 million unique lines of software" written in a variety of computer languages. The magazine goes on to quote Navy Captain David Boslaugh, who estimates that to redo these lines of code to achieve software compatibility among its computer systems "would take years, considerable expertise, and at least $85 billion."

The fact is that so-called outdated computer languages are self-perpetuating because of the enormous investment in existing programs. Take COBOL, for example. Originally developed on mainframes and rewritten for micros, it has been criticized as being slow, ponderous, and anachronistic. Yet COBOL is especially well suited to business applications, where the name of the game is software maintenance.

A prime reason for COBOL's continued popularity is that its code reads like an English sentence. In fact, there are more help-wanted ads today for COBOL programmers than for any other computer language. So much for dead languages.

Each computer language, obviously, has its strengths and weaknesses. BASIC is easy to learn but Pascal admirers say BASIC's loose format encourages sloppy programming habits. Artificial-intelligence researchers will settle for nothing but LISP while a growing body of successful professionals and midnight hackers claim FORTH is the "best" and most "serendipitous" computer language.

This month's theme is "demystifying computer languages." Starting on page 82 we present a short chronological history of the major computer languages and group them according to their characteristics and applications. Following that we have in-depth studies of five major languages, a feature about the forces behind FORTH, and an overview of the up-and-coming languages.

Chris Crawford, manager of research at Atari, who writes those wonderfully complex computer games, tells why everyone should study Latin and learn to program (page 153). The Program Factory (page 230) provides some tips on translating a BASIC program into the dialect your computer understands.

It would be much easier to conduct business if everyone spoke English, or German, or Japanese, or Tagalog, or Esperanto. But the world would be a lot less colorful, less exciting, and less culturally diverse. As with natural languages, computer languages will continue to evolve along separate paths. Compatibility has just too high a price.

Rich Friedman

Rich Friedman
Managing Editor

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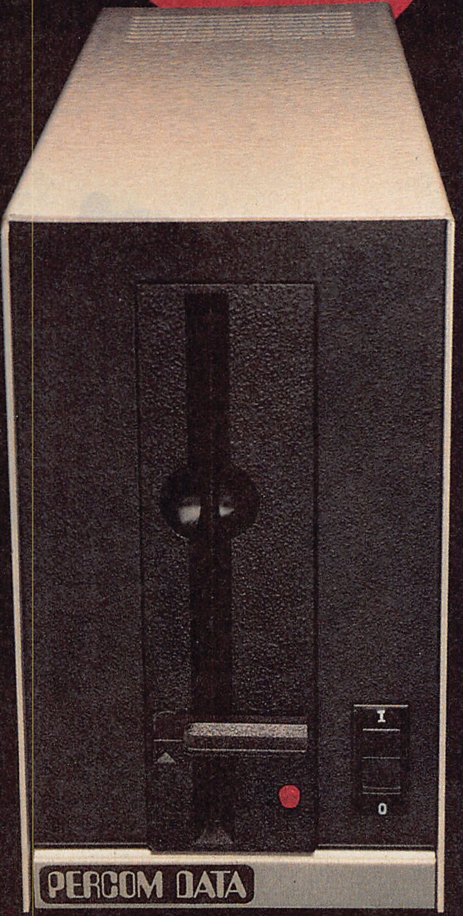

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Commodore Memory

Dear Editor:

In the May 1983 issue ("The People's Computer," page 92), your reviewer states that the Commodore 64 has only 39K bytes of memory available to a user for BASIC programs and 52K bytes available for machine-language programs. What is the rest of the memory used for?

F. J. Soderland

When you're working in BASIC, some of the Commodore's 64K-byte memory address space is occupied by the BASIC language interpreter (8K bytes), input/output (I/O) routines (4K), the character definitions (4K), the Kernal operating system (8K), the video-screen memory (1K), and work space (1K). Effectively, only the memory between 2048 and 40959—38,911 bytes—is available for storing a BASIC program.

A similar situation occurs with machine-language programs. You can use the memory between 0 and 53247, with the rest of memory occupied by I/O, the character set, and the Kernal operating system.

POPULAR REVIEWS: THE COMMODORE 64

THE PEOPLE'S COMPUTER

Printing Snafu

Dear Editor:

I enjoyed reading the first article (April 1983, page 126) in your series on programming the Epson MX-80 printer.

Obviously, it was even more fun to apply the commands as I started to practice with my Apple II Plus and Epson MX-100 Type III printer. So far I have run into only one problem. I cannot turn off the double-width mode within a single print line. When I start this mode with the CHR$(14) command, the mode remains active until the end of the line when it automatically turns off. The CHR$(20) command, which normally cancels the mode, does not seem to have any effect.

Also, in word-processing programs such as Piewriter, which I am using, I can turn on this mode with the Ctrl-N command but cannot turn it off within the same line with the Ctrl-T command. I wonder whether the fact that I use an MX-100 Type III has any bearing.

Ton. J. M. van der Kooij
Jakarta, Indonesia

It's good to hear that Popular Computing *reaches all the way to Jakarta. Microcomputing is apparently alive and well worldwide.*

Glad you enjoyed the first article in the series on programming with the MX-80. Please note that the articles deal only with the original MX-80, not the MX-100 Type III or its counterpart distributed in the U.S. (Graftrax Plus). You'll find that the program lines developed in these articles do not work very well with the newer printers.

The problem you experienced with cancellation of the double-width mode on the MX-100 Type III is somewhat of a puzzle. CHR$(20) should cancel the double-width mode on all Epson printers, whether you send it from BASIC or with Ctrl-T via a word-processing program.

Here are a few possible situations where the CHR$(20) would not work. When the double-width mode is activated with <Esc> "W"CHR$(1), then CHR$(20) has no effect. It is also possible that your CHR$(20) is being interpreted as a part of an <Esc> sequence (e.g., <Esc>"D"CHR$(20)) and therefore is not used to shut off the double-width mode. Another possibility is that your Apple is intercepting the CHR$(20) before it ever gets to the printer. This would happen, for example, if you sent the sequence CHR$(9) CHR$(20). The Apple printer interface card uses any code following a CHR$(9) to change printer modes. Or perhaps your word-processing program refuses to pass the Ctrl-T on to the printer.

If you can't find a programming error, then your computer's read-only memory may be defective. Your distributor should be able to help you isolate and fix the problem.

If you did not receive a manual with your printer, Epson will be happy to see that you get one. The person to contact is Glenn Morningstar at (213) 539-9140. The address is Epson America Inc., 3415 Kashiwa St., Torrance, CA 90505.

Incidentally, Compusoft does have manuals available on the MX-80, MX-100, and MX Type III but only for users outside the United States and Canada. The address is Compusoft Publishing Inc., 535 Broadway, El Cajon, CA 92021. . . . **David A. Kater**

Saving Data

Dear Editor:

I have a few (helpful?) comments on your Ask Popular reply (June 1983, page 18) to Jeff Adkisson, Austell, GA, which refers to the missing READ and DATA statements in Timex/Sinclair BASIC.

Watch out, Jeff! By now he has probably found out that in the array input routine

```
10 DIM T(10)
20 FOR I-1 TO 10
30 PRINT "ENTER NEXT NUMBER"
40 INPUT T(I)
50 NEXT I
60 . . .
```

he had better either delete line 10, as well as lines 20 to 50, or he will wind up with a data array of all 0s the next time he runs the program; or he should somehow start his

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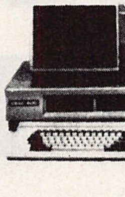

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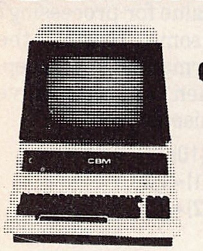

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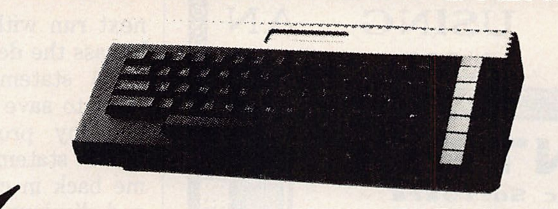

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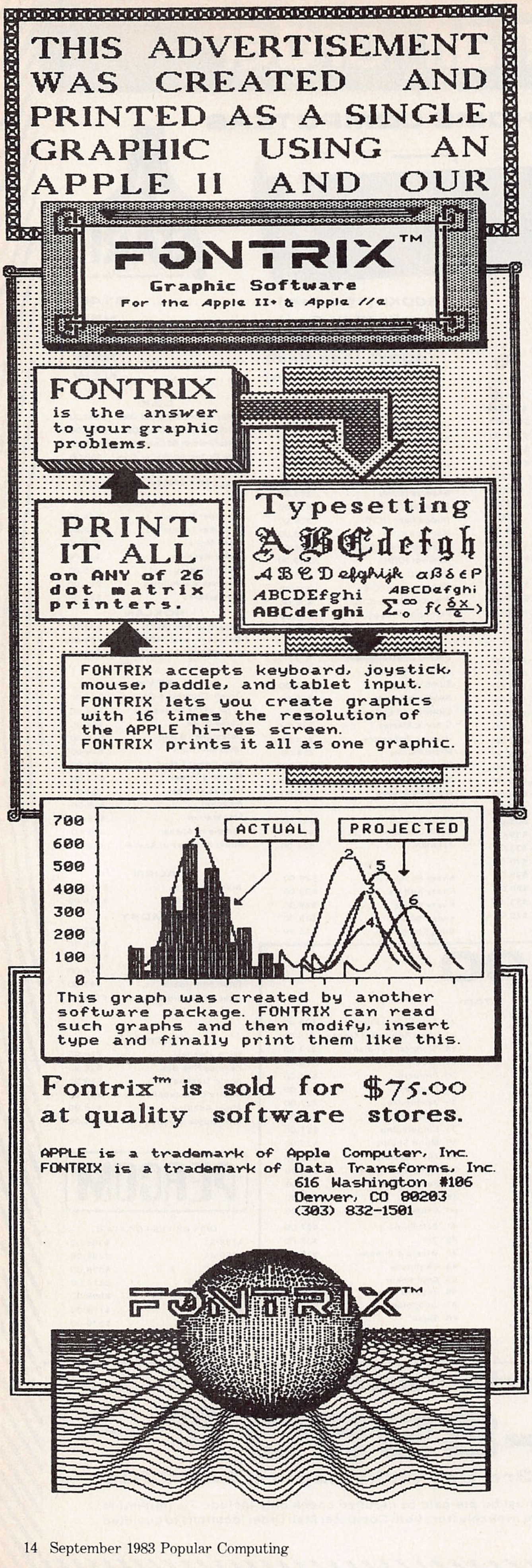

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next run with GOTO 60 to bypass the destructive DIM T(10) statement. When I want to save data arrays, I end my program with a STOP statement that puts me back in command mode and displays an instruction such as:

```
DO NOT TYPE RUN. TYPE GOTO 60.
TO SAVE, TYPE GOTO 1000.
```

If I want to retain lines 10 to 50 for future use, the end of my program might look like:

```
500 STOP
510 PRINT "DO NOT TYPE RUN.
    TYPE GOTO 60."
520 PRINT "TO SAVE, TYPE
    GOTO 1000."

1000 SAVE "PROGRAM NAME"
1010 GOTO 60
```

This format allows me to rerun the program on line without clearing the array and automatically bypasses the DIM and input routine on a LOAD command. Also, I can enter new data by using RUN, which clears the array and starts the input routine.

Perhaps I didn't understand the last part of your reply concerning sequential input values for one variable. If the values are already in an array T(10), then the READ simulation could easily be:

```
100 FOR I-1 TO 10
110 PRINT T(I);" SQUARED IS ";
    T(I)*T(I)
120 NEXT I
```

(Note that the program lines in your reply have several typos: Line 30 omits semicolons. Line 40 should be NEXT I, not NEXT A.)

If the values are not yet in an array, then just precede my lines 100 to 120 with your data input routine (lines 10 to 50—DIM T(10) and so on). Why the need for all the LET A statements, a procedure that, incidentally, requires considerable additional logic software to sequentially substitute each LET A value for processing? If, for some reason, the above format is not acceptable, then an alternative compromise is:

```
10 DIM A(10)
20 LET A(1)-1.2
21 LET A(2)-3.7
22 ...
.
.
29 LET A(10)-10.1
30 FOR I-1 TO 10
40 PRINT A(I);" SQUARED IS
   ";A(I)*A(I)
50 NEXT I
```

George Heyman
Gaithersburg, MD

Disks Are Better

Dear Editor:

I have always considered your magazine one of the better computer magazines for both the advanced computer user and the beginner. I feel your article "Getting Along with Cassette Storage" (June 1983, page 190) could be very misleading to a person looking to buy a microcomputer system.

When I first purchased my Apple II Plus, I used a cassette in order to save money. A year later, after collecting about 20 cassettes and losing a number of important files, I decided to buy a disk drive. Cassette tapes are great because of their price, but if a person is willing to spend the money to purchase an Apple or TRS-80 Model III, then he should spend the extra money to purchase at least one disk drive in order to get full use of his investment.

Cassette tape is slow. All the rewinding and checking the tape counter may not seem bad, but if you're trying to program, it's just a pain in the neck. Disk drives are fast, reliable, easy to use, and store large amounts of data on each disk. And most software is now available exclusively on disk. My advice is to forget cassettes.

Jim Fox
Peckville, PA □

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My Franklin Ace 1000 works very well, except that it emits an interference that plagues my television reception. The interference appears as diagonal lines and is strongest on channels 2 and 4. Franklin considers this normal. Do you have any suggestions? Steven Mevorah, Howell, NJ

Television interference (TVI) in the low-band channels (channels 2, 3, and 4, for example) is a common problem with computers. It is such a problem, in fact, that personal computers are required to pass Federal Communications Commission (FCC) guidelines that limit the amount of TVI a personal computer can create. The FCC requirements, however, are not so strict as to prohibit the emission of *all* interference produced by a computer.

You get the video disturbance because your TV antenna system (antenna, lead-in wire, and connectors) is picking up the radio waves that are a by-product of your computer's high-speed microprocessor. These radio waves just happen to be in the same frequency range as low-band TV, but they are generally weak. You can take several steps to control the problem.

If the interference is minor, you might try to reposition your outside antenna with a simple turn. Or if your television and computer are in the same room, you might consider separating them as much as possible by moving either the TV or computer into another room.

For more serious problems, the simplest cure is to subscribe to a local cable TV service. Because using a cable TV service eliminates the need for a conventional TV antenna near your home and the lead-in cable is shielded, you are least likely to pick up any TVI.

If cable service is not available, you should consider replacing your antenna system. Use only a directional outdoor antenna (indoor antennas will not do), and mount it on the opposite side of your house or as far from your computer as possible. Then replace your antenna lead-in cable with 75-ohm coaxial cable (the same kind the cable TV companies use). If you already use this type of cable but it is several years old, you should replace it.

Be warned that, depending on several factors, you may still continue to get a small amount of TVI. For more information, you can request the booklet entitled *How to Identify and Resolve Radio-TV Interference* from the U.S. Government Printing Office, Washington, DC 20402.

Could you suggest a few video monitors that accept the composite output from the Commodore 64? I've tried several green-phosphor monitors, but the picture is worse than the one I get on my black-and-white TV screen. Marvin J. Gardner, Santa Fe, NM

Selecting a monitor for the Commodore 64 presents three obstacles. First, the monitor must be a composite video monitor, not an RGB (red-orange, green, blue-violet) monitor. Second, the monitor must accept a low-impedance input of 75 ohms. The last obstacle to overcome and the most common source of problems is choosing a cable to connect the monitor to the 5-pin port on the computer. Because the type of cable and wiring varies with different monitors, you should contact your dealer for help with your specific model.

If you need other technical assistance, call Commodore's customer-service hot line: (215) 436-4200.

However, you need not go to so much trouble to find a monitor. Commodore Business Machines recently introduced its own monitor, the Model 1701, which has a 13-inch screen, full color, 270 by 320 dot resolution, and a built-in speaker. The Commodore 1701 also has two different input ports, which make it compatible with existing Commodore units, like the VIC-20 and early versions of the Commodore 64, as well as with the newer Commodore 64 and 128. The monitor is also compatible with a video recorder, and it lists for $299.

What versions of LISP are available for personal computers? I would like to experiment with artificial intelligence. Howard Champaigne, Portales, NM

The LISP (List Processor) programming language has been around since the early '60s, but until a recent emphasis on artificial intelligence (AI), there was little talk about LISP. Because LISP can work with word lists, sentences, and phrases, it is a logical choice for AI development. In fact, LISP has been used as the basis for a robot language at Stanford and MIT.

Microsoft markets a microcomputer version of the language, called MuLISP, which is much like the original LISP 1.5 and runs on an 8080- or Z80-based system operating under CP/M. MuLISP is also available for the IBM Personal Computer. The price is $200 ($250 for the IBM version), and it includes MuSTAR, a MuLISP editor.

Microsoft currently distributes MuLISP-80, which occupies about 10K bytes of RAM (random-access memory). Therefore, a computer with at least 32K bytes of RAM is necessary for program development. The company that developed MuLISP for Microsoft, The Soft Warehouse (POB 11174, Honolulu, HI 96828), also distributes a version of MuLISP that runs on the 8086/8088 under MS-DOS to handle bigger problems.

According to Albert D. Rich, who coauthored MuLISP-80 for The Soft Warehouse, a more powerful version, MuLISP-83, will soon be available. The new version occupies about 16K bytes of RAM, and among other additions, it offers a powerful construct function called CATCH and THROW.

When you run a program in LISP, one function calls another function, thereby building a stack of the different levels of functions. If the program you are running has gone, let's say, 10 levels deep and the system detects an error—perhaps a typing error that made a sentence syntactically incorrect—the system can throw the error back to the top of the stack, immediately unwinding the stack, and catch the error at the highest level. This fea-

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ture is important for artificial intelligence because it gives the system the ability to try alternate routes instead of simply stopping when it runs into an error.

In addition, MuLISP-83 supports random file access (MuLISP-80 supports only sequential file access), which allows more efficient management of a database. Random file access enables the system to directly access a specific record within a file, whereas sequential file access requires that the system read every record in the file until it finds the record it needs.

Microsoft (10700 Northup Way, Bellevue, WA 98004) can provide you with a list of Microsoft dealers and distributors.

Is there any way to load a program from tape into a Timex/Sinclair 1000 without erasing a resident program? Dr. Robert S. Gordon Jr., Kensington, MD

Unfortunately, an initialization routine in the read-only memory of the Timex/Sinclair 1000 clears the random-access memory just before the computer starts loading a program. This procedure makes it impossible to combine programs. But don't give up—many other people have requested that feature too. As a result, Timex is including in its new line of computers a command called MERGE, which will enable you to nest one program within another program.

Has anyone developed an efficient emulator for the old card keypunch? I need to enter large quantities of formatted data, and the auto-duplication capabilities of a keypunch are very useful. Terry S. Stewart, West Lafayette, IN

I could not find a database-management program that accepts data entry the same way a keypunch machine does, although many programs offered a few duplicating capabilities. But if you have access to a keypunch machine, you do have an alternative.

Several companies manufacture card readers that are compatible with an RS-232C serial port, and most personal computers have provisions for RS-232C devices. By adding a card reader to a personal computer, you can keypunch data cards on a standard keypunch and later feed the cards into the computer.

Here are approximate prices of the card readers and addresses of a few companies that market these machines:

$900 to $1500, True Data Corp., 17092 Pullman St., Irvine, CA 92714, (714) 979-4842.

$2500, Computer Talk, 2800 South Rooney Rd., Morrison, CO 80465, (303) 697-5485.

$2595 (80-column reader) or $1495 (68-column reader), Taurus Corp., Academy Hill, POB 278, Lambertville, NJ 08530, (609) 397-2390.

$3100 to $4125, Peripheral Dynamics Inc., 5150 Campus Dr., Plymouth Meeting, PA 19462, (215) 825-7090.

I have been under the impression that the maximum memory an 8-bit microprocessor can directly address is 64K bytes. Recently, however, I've seen ads for several 8-bit machines with a capability of addressing larger amounts of memory. How is this increase in memory size accomplished? Mark Vargo, Kingsport, TN

The process used in personal computers that enables an 8-bit microprocessor to access more than 64K bytes is called bank switching or bank selection. It's not new to mainframe or minicomputers, but until recently bank switching was uncommon on personal computers. Now, several small computers that use 8-bit microprocessors, such as the Z80, are boasting more than the standard 64K-byte memory. Here is the way bank switching works:

A typical 8-bit microprocessor has a limited number of memory addresses or bytes (64K or 65,536, to be exact). Although the number of memory addresses in a microprocessor cannot be changed, a combination of hardware and software additions can "trick" the microprocessor.

For example, if we double the memory size to 128K bytes, the microprocessor normally recognizes only the first 64K bytes in the system. But if we divide the memory into smaller but equal blocks or banks (16K-byte blocks are most often used) and add electronic switches that are controlled by software, the system software can select which 64K-byte combination of blocks to use.

This process of bank-selection can occur as often as necessary during program execution, but if the system software that controls the process is not efficient, processing time is considerably slower.

A more elaborate system can even use bank-selected memory with more than one microprocessor, which allows the system to handle large amounts of memory quickly. This configuration is particularly useful in a multiuser environment.

I read your article (April 1983, page 146) on the UCSD p-System. Can you tell me where I can write to get more information? D. L. Taylor, Dartmouth, N.S., Canada

The UCSD p-System is an operating system that was developed to allow universal program portability. In other words, a program written for the p-System will run on an Apple, an Osborne, or any other personal computer without modification.

The p-System can operate on most of the popular microcomputers based on 8- and 16-bit microprocessors, including the 8080/8085, 8086/8088, 68000, Z80, 6502, 6809, 9900, LSI-11, PDP-11, Z8000, and 16000. The p-System supports such languages as UCSD Pascal, FORTRAN-77, BASIC, and assembly language and even lets you write programs using any combination of languages.

The University of California at San Diego (UCSD) has licensed Softech Microsystems to further develop the system. Softech is working with original-equipment manufacturers and distributors to produce the system for all popular microcomputers. You can contact Softech Microsystems at 16885 West Bernardo Dr., San Diego, CA 92127.

If you want more technical information on the p-System, check your library or bookstore for *Introduction to the UCSD p-System* (Sybex Inc., Berkeley, CA, 1982), by Charles W. Grant and Jon Butah.

Can I use a light pen with my VIC-20? If so, where can I get one? Tim Sherburne, Trout Lake, WA

Yes, you can use a light pen with the VIC-20, and at the time of this writing, Commodore Business Machines was completing the necessary software to drive the new light pen the company will offer. Commodore's light pen plugs into the joystick port of the VIC-20 or Commodore 64, and it should be available now.

You might also want to consider three other light pens that work on the VIC-20:

The Edumate Light Pen, $29.95, from Programmer's Institute, POB 3470, Chapel Hill, NC 27514, (919) 967-0861.

The LP-10, $39.95, and LP-15, $119.95, from Tech-

Sketch Inc., 26 Just Rd., Fairfield, NJ 07006, (201) 227-7724.

What are the risks or problems involved in purchasing computer software from mail-order discount vendors who advertise their products in computer magazines? Ed Dadey, Marquette, ME

Buying computer programs from mail-order suppliers can save you 10 to 20 percent or more of the list price, but a caveat emptor is certainly in order.

Always remember the reasons mail-order prices are lower: the overhead is low because the vendors deal in large volumes, and vendors do not have to devote much time to individual customers. The latter might not be crucial when you're buying an arcade-game program for $20, but when you purchase a complicated applications program, such as database-management or word-processing software, you might need individual attention.

Of course, most reputable mail-order companies will answer your questions when you call, but then you run into the expense of a long-distance phone call every time you have a question or encounter—heaven forbid—a previously undetected bug in the program. The money that you originally saved can be quickly lost to your long-distance telephone bill. On the other hand, had you purchased the software from a local dealer, you could stop by and talk face-to-face with someone who can help you.

Also keep in mind that the number of mail-order software vendors is incredible, and the frequency with which new mail-order companies spring up and others disappear is nothing less than amazing. Fortunately, most mail-order companies are legitimate, but how can you be sure? Don't hesitate to contact the Better Business Bureau or the Chamber of Commerce in the company's city. Either can alert you to any problems.

Is mail-order bad? No. If you order from an established company and you're familiar with the software you're buying or you have a programming background and are not likely to require much support, buying through the mail can save you a bundle.

I recently opened up my VIC-20 and found the 6502 chip. Can I change this to a 16-bit 8086 or 8088 chip for improved performance? Are there any other modifications I would have to make? Vince Mancini, Winfield, IL

Switching microprocessors simply isn't feasible, especially when you're talking about swapping a 16-bit chip with an 8-bit chip.

Microprocessors vary in electrical characteristics, protocols for communicating with memory and input/output devices, numbers of connection pins, instruction sets, and so forth. Almost all the software and hardware of a computer are designed around its microprocessor, making it virtually impossible to swap microprocessors without major modifications to the rest of the computer.

It is possible, however, to connect a "foreign" microprocessor to a computer as an external device. This scheme requires a special interface and special software. Hewlett-Packard uses such an approach to provide CP/M capability on its HP-86 and HP-87 computers. Microsoft does the same to provide CP/M capability on the Apple II. Metamorphic Systems (La Jolla, CA) offers an 8088 coprocessor board that lets the Apple II or IIe run MS-DOS. I haven't heard of any such enhancements for the VIC-20, however. □

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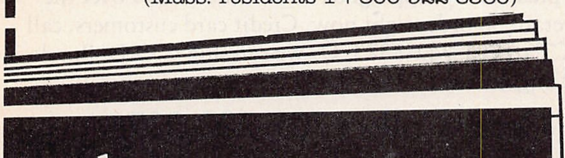

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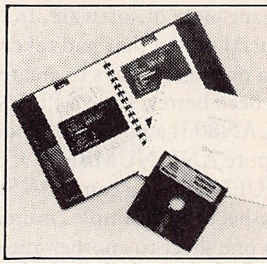

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In desperation, I bought a micro-computer and started to teach myself how to program. At that time, there were no financial planning packages available. And the prospect of teaching a programmer about financial models seemed more intimidating than learning to program myself.

Seven months of nights and weekends later, I'm pleased to say I had a 30 spreadsheet, consolidated financial model up and working. The estimated cost was about $50,000.00 in time, materials and equipment . . . but it was worth it. Now I could update the company's financial plan in a 10th of the time.

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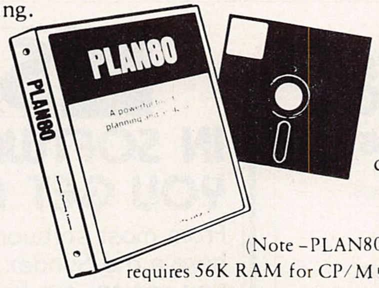
When 'calc' programs became available, I bought one and quickly realized the time and money that would have been saved had they been available sooner. But I soon appreciated that a computerized spread sheet program also had very major limitations for financial modeling.

Entering values and formulas, one cell at a time, is slow and clumsy. The problem of consolidating and running up to 30 inter-related spread sheets, in the correct sequence and without errors, becomes very difficult. And the complexity of thousands of formulas, all using co-ordinates like "A5*C4+B6", would have made the system almost impossible to revise.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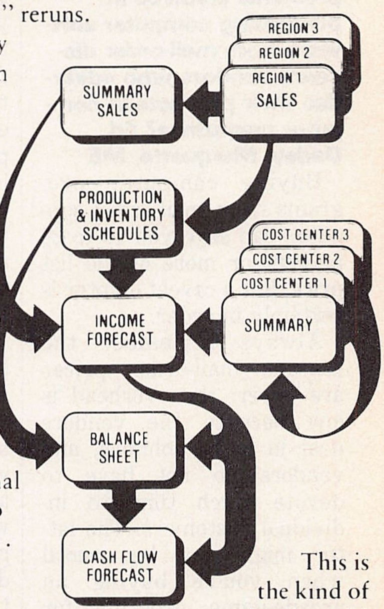
When I bought PLAN80, I was amazed at the power of this brilliant piece of software. In using it, I soon realized that the financial model that had taken me months to create, would have taken only a few days to create with PLAN80. The results would have been better, since a PLAN80 model is so easy to revise.

PLAN80 is a powerful modeling tool that allows you to compute ANY NUMBER OF SPREAD SHEETS IN ANY SEQUENCE. You can CONSOLIDATE any number of worksheets with simple commands. You can transfer any values from one sheet to another automatically. You can even switch row values in one worksheet to column values in another. And once your model is built, it runs without any further help from you, from beginning to end.

Your entire model is created using English-like statements such as "Margin = Sales – Cost". You enter data values into your worksheets with simple fast commands like "Sales = 1200 (*110%)" to create a series of values that increase monthly at 10%. And your model is built with your own familiar word processor . . . just like typing a letter.

PLAN80 also has an interactive display mode like the 'calc' programs for quick "what-if" reruns. It displays results graphically on your screen. It has built-in functions to automatically total rows & columns and accumulates values. Plus special trig, financial, depreciation, amortization, net present value, ACRS and other time saving functions.

PLAN80 stores it's data in 'packed' format in your computer memory so you can use bigger spreadsheets when necessary. It has the ability to produce professional formatted reports with up to 6 decimal places if needed . . . with automatic printing and paging . . . and the ability to store your finished reports on your disks so you can incorporate them into written reports with your word processor.



This is the kind of inter-related model PLAN80 automates with ease

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INFOWORLD rated the original version of PLAN80 as excellent in all 4 categories: PERFORMANCE . . . DOCUMENTATION . . . EASE OF USE . . . ERROR HANDLING. It has been greatly enhanced since then to provide even more power and features.

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Once you've tried PLAN80 you won't want to use your 'calc' package again for any serious modeling. I should know, I haven't used mine since I got PLAN80. In fact, I'm so enthusiastic about PLAN80 that I made a special deal with the author to market it.

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Russ Walter: Computing's Best-Kept Secret

Russ Walter, a 35-year-old author and computer instructor, is a bit like Charlie Lau, baseball's premier batting coach: neither is a household name, but they're both highly regarded by their peers. As the Boston Computer Society's unofficial "answer man," Walter is king of the East Coast computer cognoscenti. Almost single-handedly, he has shattered the stereotype of computer teacher as absent-minded professor. Walter usually attends computer shows in a full-length warlock costume, and as browsers partake of his shoot-from-the-hip humor they sometimes get the feeling that this guy really *does* hail from a computing coven somewhere in rural New England.

But the only secret in Walter's life is a series of eight computer books called *The Secret Guide to Computers* that, at $29.60, is hands down the biggest bargain in computer tutorials in our hemisphere. Where else can you get eight comparably priced books that run the gamut from *Hassles in BASIC* to *Hassles in Applications*? Now in its eleventh edition, *Secret Guide* is imbued with the same obsessive quality found in Will and Ariel Durant's history books: Walter wants to tell the whole story, from the history of microprocessor families to frequently encountered problems in the ALGOL language.

Russ Walter, flanked by associates Priscilla Grogan and Carey Gersten, beckons to computing's free spirits.

Because Russ is a very committed man as well as a light sleeper, every volume of *The Secret Guide* contains his not-so-secret phone number (617-266-8128) and an open invitation to phone him at all hours—providing the caller isn't completely off-the-wall ("Where can I find X-rated software?") or lazy ("Hi, Russ—I've got three hours to kill, so can you tell me which brand of computer to buy?")

If CBS ever decides to replace Andy Rooney with a *60 Minutes* computer pundit, they'd need to look no further than Russ Walter. Here are a couple of wry Walterian observations of the sort that enlivens nearly every page of *The Secret Guide to Computers:*

•On the efficacy of federal retraining programs: "When the government starts sinking money into programs to retrain people for high-tech jobs, most of that money gets wasted. Let me give you an example. In Massachusetts several years ago there was a combined federal and state program to retrain school teachers to be COBOL programmers. Some schools got very rich by running these programs. A few of the students in the first wave of classes did get jobs as COBOL programmers, but the next bunch of graduates had a very difficult time finding jobs. There's only so much slack in the job market at any given time. One of the things people are reluctant to talk about is that the mainframe computer field is pretty stagnant right now. There is, therefore, no shortage of entry-level people in that end of things. The government won't accomplish very much if it decides to throw a lot of money into programs to train elementary COBOL programmers. The majority of job openings—no matter what the size of the machine—are for advanced programmers."

•On preparing the newest edition of *The Secret Guide to Computers*: "Writing a computer book is a lot like painting the George Washington Bridge. By the time you get to the end, it's time to start all over again."

The Secret Guide is the first collection of computer books that one might dare call literature. Walter couldn't have packed more practical tips into his eight volumes if he'd used a shoehorn, yet the writing still has a graceful, witty style. He obviously loves computers—and loves to write about them just as much as Red Smith loved to write about baseball—yet the icing on *The Secret Guide* is its freewheeling zaniness.

You can buy the complete eight-volume set of *The Secret Guide to Computers* from the author. Make your check for $29.60 payable to "Secret Guide to Computers" and mail it to Russell Walter, Suite #3, 92 St. Botolph St., Boston, MA 02116. ☐

Photograph by George Dillon

Computers Fuel Crosstown Rivalry

UNIVERSITY OF NEBRASKA
UNION COLLEGE

Both colleges are in Lincoln, Nebraska, but the contrast couldn't be greater. On one side of town sits the University of Nebraska—"Big Red," the perennial Big Eight football contender—with an enrollment of 25,000 students. In the southeastern corner of Lincoln is Union College, a relatively tiny (just more than 1000 students) private college affiliated with the Seventh-Day Adventist church. Yet Union College is forging ahead with its plans to put 500 computer terminals, all linked to the college's mainframe computer, in its dormitory rooms within the next year. Meanwhile, University of Nebraska Professor Lester Lipsky is conducting biweekly sit-ins at the office of Chancellor Martin Massengale to protest what Lipsky calls "a university computer system that's archaic, decaying, dilapidated, and a disaster."

In contrast, Union College president Dean Hubbard isn't getting hassled by any of his professors. They're all stubbornly loyal to his administration because in 1977 he implemented a farsighted program that calls for, among other things, free computer terminals for all professors. So while Chancellor Massengale worries about Lipsky's next visit, Hubbard is coolly taking phone calls from the likes of CBS anchorman Dan Rather. Everyone wants to know how Hubbard could have been so prescient.

"In 1977, Union College came up with a comprehensive six-year master plan and made a major commitment to academic computing," says Hubbard. After much debate, the administration elected to put a dumb terminal in every dorm room for eventual access to the college's mainframe. Currently about 100 such terminals have been installed, and a microcomputer lab houses IBM Personal Computers, Apples, and Hewlett-Packards.

Union College's six-year plan paid special heed to students' writing skills. With the aid of word-processing software, says Hubbard, students are now able to revise papers much more easily than in the longhand-and-typewriter days.

The computer innovations haven't ceased now that Union is in the twilight of its six-year plan. Next year Union freshmen will be required to take a two-credit course in computer literacy. Students with prior experience can gain advanced placement in a more detailed text-editing and word-processing course.

President Hubbard feels that the dorm terminals won't gather dust. Three of his own children are presently enrolled at Union College, and all have shown great curiosity about computers.

Despite the success of his administration's computer policies, Hubbard maintains that Union College is not forsaking its commitment to liberal arts and interdisciplinary programs. Across town, administrators at the University of Nebraska wonder how appropriations for teacher salaries and new hardware can keep pace with the number of undergraduates clamoring for admission to the computer science department.

The University of Nebraska may be a perennial contender for an Orange Bowl bid, but it's losing the Computer Bowl to a tiny crosstown college. ☐

'Lucky Dogs' Win Computers

Allen Products Company Inc., maker of Alpo dog food, is conducting a nationwide retail promotion called the "Lucky Dog" Supergame, and can you guess what the prizes are? If you said 1100 platinum pooper scoopers, you'd be barking up the wrong tree. The company is giving away 1100 Commodore personal computers.

Consumers can play the "Lucky Dog" Supergame by purchasing any specially marked Alpo product. Game pieces, found on the reverse side of can labels or as inserts in other products, determine winners. One hundred lucky dog owners will receive Grand Prizes (Commodore 64s) while the 1000 First Prize recipients will get Commodore VIC-20s.

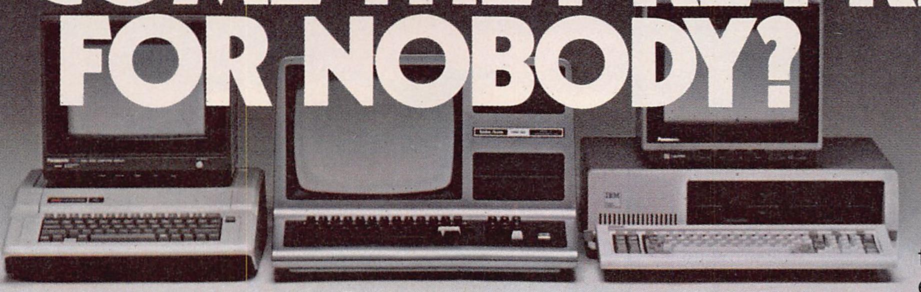
Does Allen Products' computer giveaway mean that Alpo spokesman Lorne Greene is losing his credibility with dog owners? What's the connection between microprocessors and dog chow? Tyrone Allen, the company's senior product manager, has a succinct explanation: "There's a lot of consumer interest in personal computers. They're probably the hottest thing going as far as consumer marketing is concerned."

But popularity wasn't the only reason Alpo latched onto personal computers. Although there's no direct market research linking potential computer buyers with dog owners, Allen notes that "there was some research done on video games and dog owners, and we had to make the assumption that the two (video games and computers) would go together." That research compared dog owners with the general population and concluded that a significantly larger percentage of dog owners (38 percent more) plays video games. Thus Allen Products' hope that the Commodore giveaway will appeal to video-game players who have yet to buy computers.

Keep in mind that this is no small gamble on Allen's part. The computers being given away in their "Lucky Dog" promotion have a sug-

Illustration by Iosif Teodorescu

IF PERSONAL COMPUTERS ARE FOR EVERYBODY, HOW COME THEY'RE PRICED FOR NOBODY?



$1395* APPLE® IIe 64K

$999* TRS-80® III 16K

$1355* IBM® PC 64K

A personal computer is supposed to be a computer for persons. Not just wealthy persons. Or whiz-kid persons. Or privileged persons.

But person persons.

In other words, all the persons whom Apple, IBM, and Radio Shack seem to have forgotten about (including, most likely, you).

But that's okay. Because now you can get a high-powered home computer without taking out a second mortgage on your home.

It's the Commodore 64. We're not talking about a low-priced computer that can barely retain a phone number. We're talking about a memory of 64K. Which means it can perform tasks most other home computers can't. Including some of those that cost a lot more. (Take another look at the three computers above.)

By itself, the Commodore 64 is all the computer you'll ever need. Yet, if you do want to expand its capabilities some day, you can do so by adding a full complement of Commodore peripherals. Such as disk drives. Modems. And printers.

You can also play terrific games on the Commodore 64. Many of which will be far more challenging than those you could ever play on a game machine alone.

And as great as all this sounds, what's even greater-sounding is the price. It's hundreds of dollars less than that of our nearest competitor.

So while other companies are trying to take advantage of the computer revolution, it seems to us they're really taking advantage of something else:

Their customers.

*Manufacturers' suggested list prices as of March 20, 1983. Monitor included with TRS-80 III only. Commodore Business Machines, P.O. Box 500R, Conshohocken, PA 19428; Canada–3370 Pharmacy Avenue, Agincourt, Ont., Can. M1W 2K4.

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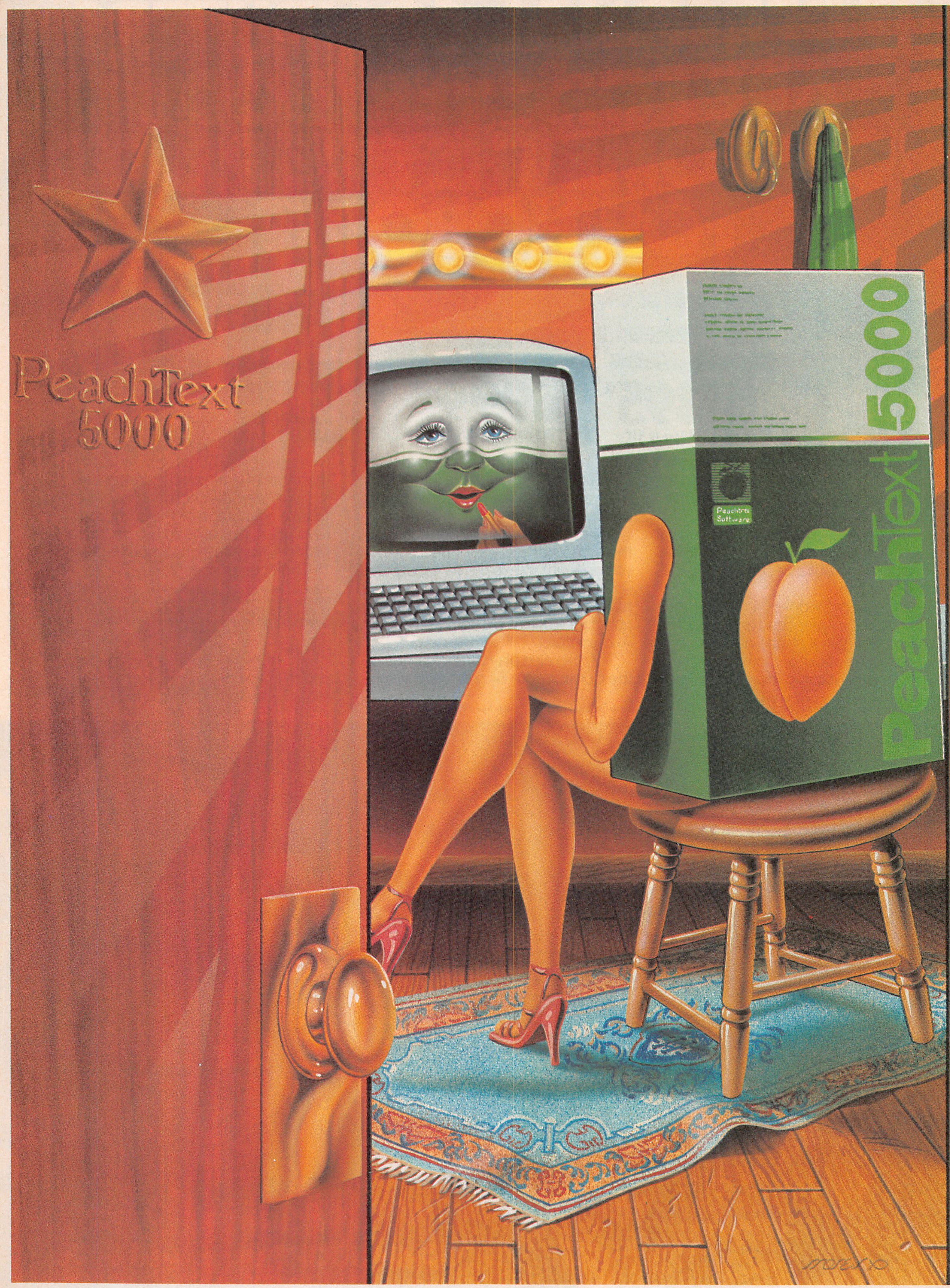
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We've even installed the Random House Electronic Thesaurus™ in PeachText.

Spelling Proofreader. This high-performance package can check a 10,000-word document for spelling and typographical errors in less than two minutes.*

2 Financial planning

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3 Data management

List Manager. This module uses Peachtree's state-of-the-art screen manager and index file manager to give you complete control over the design and use of mailing lists, labels and other files or reference aids. Output can be used with the PeachText word processor to individualize form letters or template documents.

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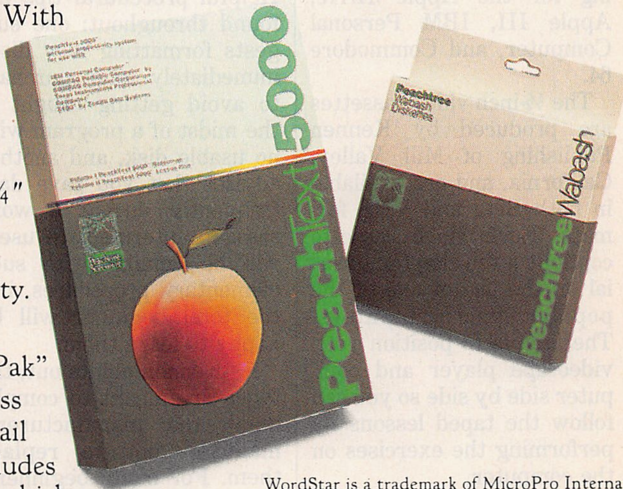

A coupon to get Peachtree's "Access Pak" for $10.00. The Access Pak, which has a retail value of $525.00, includes Information Access, which allows you to extract information from Peachtree accounting products for use with PeachText 5000 applications. And you get file converter programs to make existing WordStar,® Easy Writer™ and VisiCalc™ files usable with PeachText 5000—because you shouldn't have to suffer because you've waited this long for the complete personal productivity system.

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*In actual trials using an IBM Personal Computer and 320K diskettes, Spelling Proofreader checked a 10,024-word document in one minute and 15 seconds, using the standard 20,000-word dictionary supplied with the package. Checking times may vary depending on your hardware.

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gested retail value of more than $750,000. "We've given away beefsteak and we've had a canned dog food promotion where we gave away $5000 and other monetary prizes, but this is by far the largest promotion we've run," says Allen.

After hearing about the Alpo promotion, one author of computer books quipped, "I've been vindicated. For years I've been trying to sell a book called *Lassie Learns Logo*, and this proves there's a market!"

Even if you don't own a pooch, you can still win a Commodore from the folks at Alpo by requesting free "Lucky Dog" game pieces through the mail. To receive your free piece send a self-addressed stamped envelope by September 30, 1983, to Alpo "Lucky Dog" Game Piece Request, POB 1490, Philadelphia, PA 19105. You're limited to one piece per request and one request per day. The contest winners will be announced on October 31, 1983. □

User Guides on Videotape

For computer users who hate wading through manuals, there's new hope in the form of video-cassette training for the Apple II/IIe, Apple III, IBM Personal Computer, and Commodore 64.

The ½-inch video cassettes are produced by Kennen Publishing of Mill Valley, California, and are available in both Beta and VHS formats. Each video cassette contains a ten-chapter tutorial on the use of one of the popular microcomputers. The idea is to position your videotape player and computer side by side so you can follow the taped lessons by performing the exercises on the computer.

While not used obtrusively, the video cassette's graphics effectively enhance the material in each chapter. In chapter one, an introduction to the hardware, the video highlight is the eye-catching fade in which the computer's plastic case disappears to reveal its inner circuitry. Random-access memory, read-only memory, and other components are then explained behind close-up shots of each.

Once you've been introduced to the basic concepts and terminology, ensuing chapters cover setting up your system, using the keyboard, dealing with disks, buying and running software, and elementary programming in BASIC. Helpful procedural tips are found throughout: one suggests formatting new disks immediately after purchase to avoid getting caught in the midst of a program with no usable disk, and another advises that you save data frequently during a work session. Intermediate users will be familiar with such elementary procedures, but the total beginner will be happy to learn them.

As Kennen points out, the tapes are meant to complement the manufacturers' manuals, not to replace them. For many beginners, the opportunity to actually see procedures as they are performed will make the operations much less intimidating. This visual preface to hands-on computing may even take some of the drudgery out of reading the user manuals.

The tapes, on the market since last September, have been greeted with enthusiasm despite minimal marketing support. When a newspaper columnist in San Francisco wrote that Kennen was seeking subjects to pretest the tapes, more than 500 people responded—including housewives, the head of an advertising agency, a network TV cameraman, and senior citizens. All were eager for a videotaped introduction to the mysteries of microcomputers. Such excitement has finally prompted a vigorous marketing push. Deltak, a leading publisher of videotaped training materials, has selected the Kennen tapes as the keystone of its microcomputer training program for Fortune 2000 companies.

The microcomputer training tapes should be available from your local computer store, or you can order directly from Kennen Publishing, Building E, 150 Shoreline Highway, Mill Valley, CA 94941 for $69.50 (plus $2.50 for shipping). □

Computerdom's Battle of the Brainiest

The old-fashioned spelling bee is facing extinction because kids today would rather go head-to-head in a nationwide "computing bee" instead. Thousands of junior and senior high school students are doing just that in a series of computer contests organized by the American Computer Science League of Providence, Rhode Island. Five months of contests culminate in an All-Star showdown that determines who'll take home the gold—and a bundle of prizes.

"Our staff of four teachers formulates the questions for the tests and administers the contests," says Marc H. Brown, ACSL Director. (Brown University's computer science department also has a hand in ACSL functions.) "The computer problems are tailored to motivate students to pursue topics that might not be included in their own curricula, to show there's more to computer science than just programming," explains Brown. The League has already been hailed by the New England Association of Secondary School Principals, and contest questions have even formed the basis for entire high school courses.

"We started five years ago with six competing schools, and now at least 600 are participating," says Brown. About 350 schools take part in the actual contests; others find that integrating the problems and contest quizzes into their courses is an effective educational tool.

"It's made an exciting difference for our students," says Andre Samson, who coaches the computer team from the W. T. Woodson High School in Fairfax, Virginia (one of this year's finalists). "Exposure to new areas of programming like assembly language, bit-string flicking, and Pascal, as well as the opportunity to see new techniques and methods of programming, has really expanded the team members' computing horizons," he adds. As a result, Woodson's team is preparing to square off with Milford Area (New Hampshire) Senior High in this year's final match. "The element of peer-group pressure has inspired the team to actually run its own study groups in the school library," reveals Samson, who teaches calculus and computer science when not busy coaching the team.

The road to the finals is paved with glitches, bugs, and more than a few crashed programs. It begins with study materials and sample problems that league-affiliated schools receive each month. A few weeks later school officials administer the actual test.

The secondary school competitors deal with computer

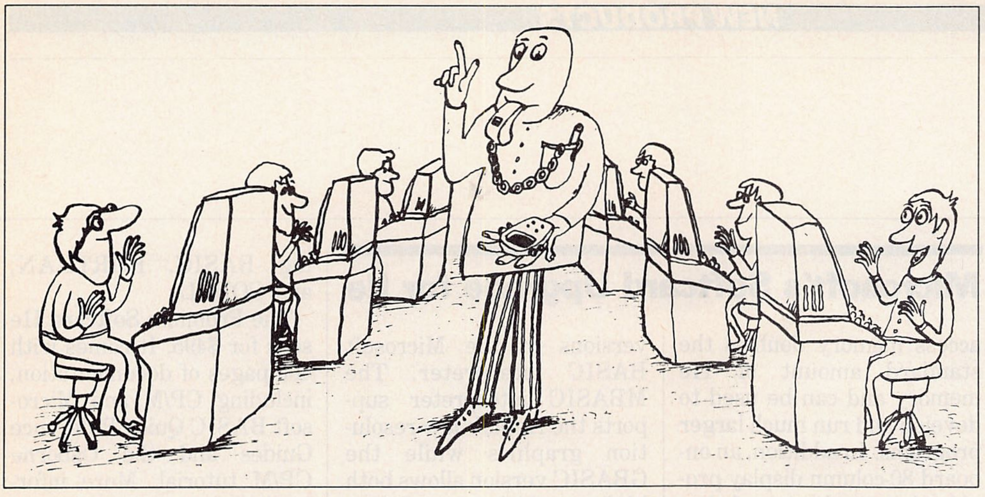

Illustration by Iosif Teodorescu

theory before advancing to practical applications. For instance, they're required to analyze algorithms and lines of code to determine what each tells the computer to do. Dexterity in dealing with binary, octal, and hexadecimal numbers plays an important part in programming, and it's certainly not overlooked in the league's tests. The competition's last hurdle involves the real thing: students write their own programs to solve a problem posed by the league's testers.

A school's score is determined by combining the grades of its top five students. The ACSL tabulates the results and announces them in a monthly newsletter. In addition to announcing school and individual scores, the newsletter also offers listings of programs deemed most exemplary by the ACSL. The tests grow progressively more difficult throughout the five-month contest; after the lightweights have been eliminated, the top-scoring teams from each state meet for the All-Star Team Playoff. An Individual All-Star Playoff at various regional sites is also coordinated by the ACSL.

Even if a team doesn't win big, students still pick up a great deal of practical know-how and glean valuable insights into programming. The winners, of course, take home more than the thrill of victory; the booty includes books on advanced mathematics and programming, magazine subscriptions (BYTE and *Computer Classroom News*), and plenty of trophies. But no "computing bee" would be complete without a few computers as top prizes for the national champions. Last year Sinclair ZX81s were presented to the victors, and Brown hopes to award even bigger hardware prizes this time.

If you want to find out more about getting your school involved in next year's competition, contact Marc H. Brown at the American Computer Science League, POB 2417A, Providence, RI 02906. □

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Microsoft's Softcard Upgrade for IIe

Microsoft is now offering an upgraded version of its famous Softcard to owners of the Apple IIe computer. The Premium Softcard IIe combines four important system enhancements in one integrated package. The card plugs into the IIe's video slot.

Like its predecessor, the Softcard IIe is Z80-based and comes with CP/M. The card's 64K-byte random-access memory doubles the standard amount of IIe memory and can be used to develop and run much larger programs. In addition, an onboard 80-column display provides better viewing of electronic-spreadsheet, word-processing, and other business-related programs.

The Softcard includes two versions of the Microsoft BASIC interpreter. The MBASIC interpreter supports the Apple's low-resolution graphics while the GBASIC version allows both high- and low-resolution graphics. The upgraded Softcard from Microsoft is also compatible with many language compilers, including BASIC, FORTRAN, and COBOL.

The Premium Softcard IIe sells for $495. It comes with 400 pages of documentation, including CP/M and Microsoft BASIC Quick Reference Guides and the Osborne CP/M tutorial. More information is available from Microsoft Corp., 10700 Northup Way, Bellevue, WA 98004.

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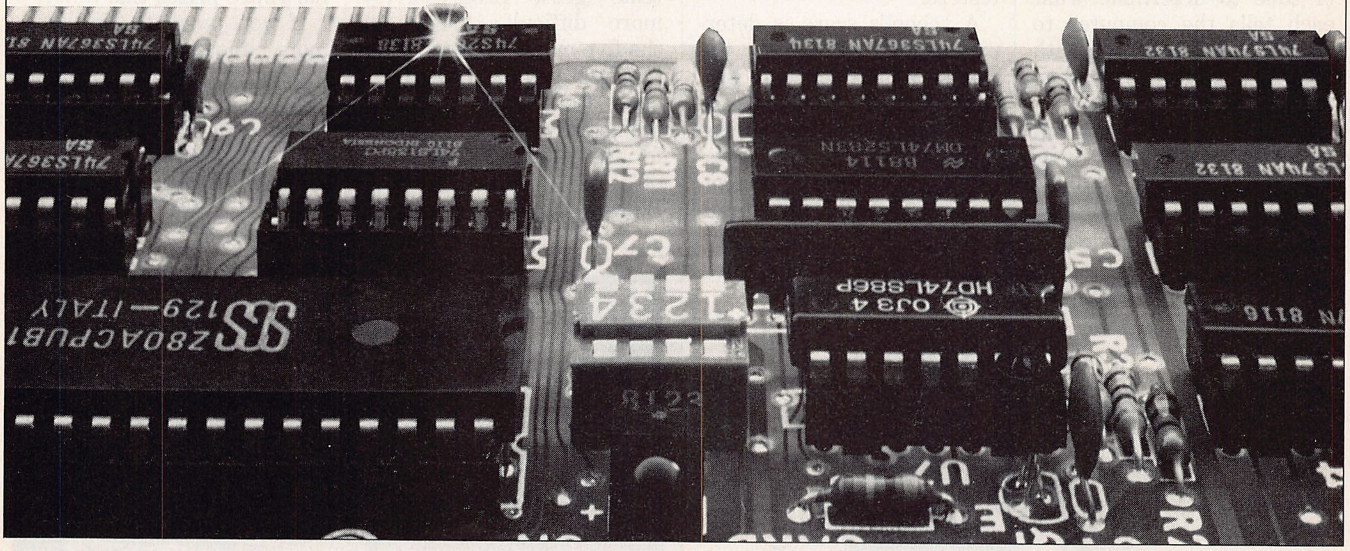


The Multi 16

Mitsubishi has recently introduced the Multi 16, a 16-bit microcomputer that gives high performance at a reasonable price. Offering an 8088 microprocessor, up to 384K bytes of RAM (random-access memory), and the CP/M operating system, the Multi 16 is aimed at business and scientific markets.

Available software covers the complete range of applications. High-level languages include BASIC, COBOL, FORTRAN, and Pascal. Programs will encompass such areas as numerical subroutines for statistical and mathematical analysis, and Multiplan, an electronic-spreadsheet.

The Multi 16 comes with high-resolution color graphics (640 by 400 dots), an 8-color video display, emulators for the IBM 3270 and Tektronix 4010, and two 5¼-inch disk drives. System prices start at $2700.

For more details, contact Mitsubishi Electronics America Inc., 2200 West Artesia Blvd., Compton, CA 90220.

Circle 201 on inquiry card.

Cleaner Screens

Adamark Inc. is offering an antistatic cleaner and conditioner for CRT (cathode-ray tube) screens. The new cleaner, called CLR, uses superior wetting agents to provide quick screen cleaning with long-lasting antistatic properties.

Static-charged particles are a common problem afflicting CRT screens. When such particles mix with dirt and grime in the air, they are drawn by magnetic attraction (produced by the CRT) to the screen, causing poor visibility that often leads to data-entry errors. To slow down the buildup of these particles, CLR uses a proven antistatic chemical that was originally designed for use in the Apollo space program.

CLR is packaged in a 4-ounce spray-top dispenser for easy storage near the terminal and costs $5.95. Multiterminal users can purchase CLR in cartons of 12 units or cases of 72.

For further information, contact Adamark Inc., POB 234, Ada, MI 49301.

Circle 202 on inquiry card.

Hard-Disk Drive with Built-in Backup

Alloy Computer Products has announced its Micromate disk drive, an 8-inch, 45-megabyte Winchester unit designed specifically for S-100-bus computers. A key feature of the Micromate is its 13.4-megabyte cartridge drive built directly into the system for convenient backup. Both disk and cartridge drives are driven by a single power supply. Also included in the $5495 unit is the interface that links the system to the user's computer.

The Micromate uses the popular Micropolis 1223 hard-disk drive. The 1223 has a 42-millisecond access time and a transfer rate of 500K bytes per minute.

Further information is available from Alloy Computer Products, 12 Mercer Rd., Natick, MA 01760.
Cicle 203 on inquiry card.

Parts to Spare

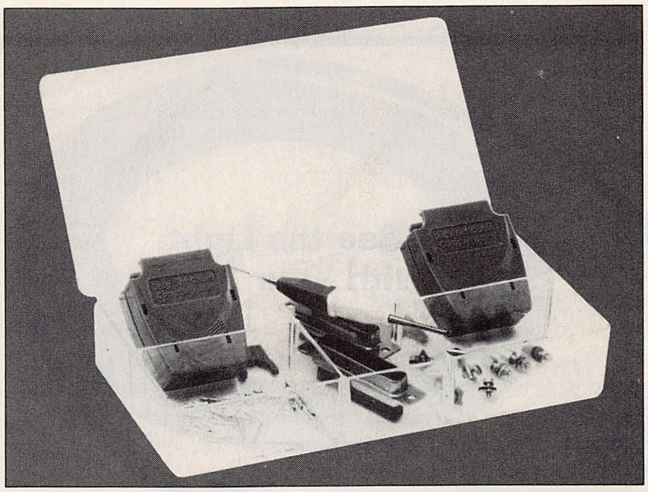
What do you do when your serial printer cable breaks on the night before a major project is due? One solution to this problem is Data Set Cable's RS-232C spare parts kit. Packed in clear plastic boxes for easy storage and access, economy and deluxe versions of the kit are priced at $19.95 and $37.50 respectively. The economy kit contains enough parts to assemble a complete RS-232C cable; the deluxe package has twice as many. (Cable is not included.)

Parts include cable hoods, 25-pin D-25 connectors, insertion-extraction tool, insertable pins and sockets. The total cost of the kit is much less than if you bought each part separately.

Write to Data Set Cable Company, 722 Danbury Rd., Ridgefield, CT 06877, for further information and complete catalogs.
Circle 205 on inquiry card.

ALLOY
micromate

Micromate provides 45 megabytes of storage for S-100 bus computers.



Spare parts kit enables users to construct or repair RS-232C cables.

Printer Interface for Commodores

The Card/? (pronounced card print) is the first microprocessor-controlled parallel-printer interface for the Commodore VIC-20 and 64 computers. Featuring an 8-bit, 8-megahertz microprocessor with 1K bytes of onboard firmware, the Card/? lets you plug any standard parallel printer into your computer.

By using all of Commodore's own printer commands in conjunction with seven additional commands added by the interface, the Card/? lets you run all currently available programs without any modification to hardware or software. The new printer interface compensates for all the Commodore ASCII (American National Standard Code for Information Interchange) irregularities.

You can control features such as uppercase/lowercase selection and automatic line feed after carriage return either from the keyboard or by program. Additionally, the unit offers a graphics mode that passes all character-string numbers without modification. The interface also features a special program-listing mode that automatically substitutes bracketed letters in place of graphics characters in program listings.

The Card/? includes all necessary cables and connectors for the parallel printer interface. Suggested retail price is $79.95.

More information is available from Cardco Inc., 3135 Bayberry, Wichita, KS 67226.
Circle 204 on inquiry card.

Inka Dinka Do

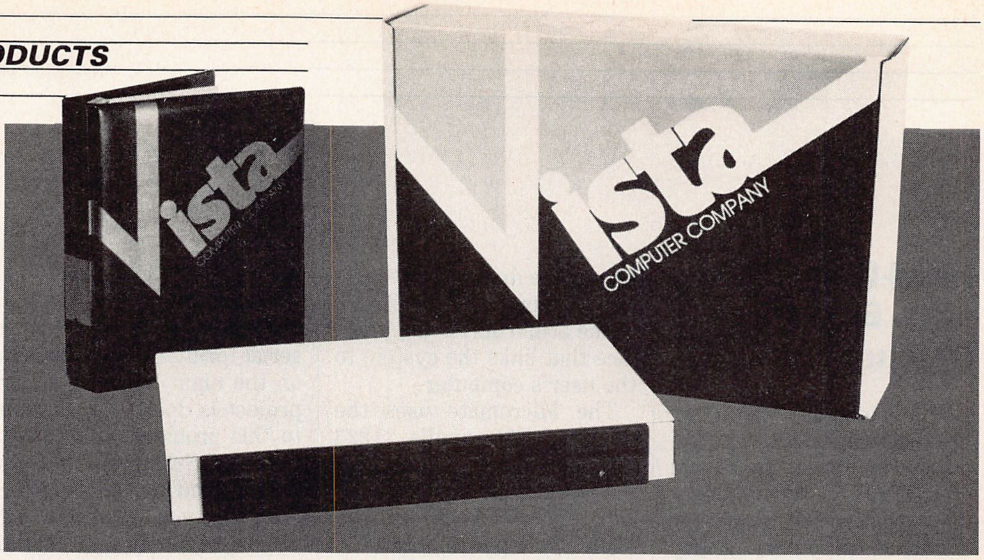
Ink-A-New is a re-inking kit that recycles exhausted fabric printer ribbons to deliver sharp, black copy at a fraction of the cost of a new ribbon. Each kit costs $32 (plus $3 shipping) and includes a re-inking machine that's custom-designed to accommodate any one of a wide variety of ribbon cartridge types, two ounces of ink, and instructions.

For more information, contact Ink-A-New, POB 229, Manhasset, NY 11030.
Circle 206 on inquiry card.

A "Quartet" of Two

Vista Computer Company Inc. has introduced the Quartet, a pair of Apple-compatible 5¼-inch disk drives that can store as much data as four Apple units while occupying the space of only a single drive. Using special utility software, Quartet can function just like a pair of Apple disk drives.

A complete Quartet package includes two thin-line drives that will perform in dual-side/40-track or single-side/35-track modes, a controller, and software modifications for Apple DOS, CP/M, and Pascal.



The Quartet dual disk drive system can replace four Apple disk drives.

For more information, contact Vista Computer Company Inc., 1317 East Edinger, Santa Ana, CA 92705.
Circle 207 on inquiry card.

See the Light with Your Apple

Light Meter II gives your Apple some insight about light.

Light Meter II is a plug-in light meter and software package for Apple II computers from Centronic Inc. The $69.95 device can be used in a variety of applications, including laboratory photometric measurements, ambient lighting control, photographic light measurements, and solar energy management.

Easily installed via its attached dual-inline-package plug, Light Meter II is capable of accurately measuring both high and low light levels. Its accompanying software can be used as either a stand-alone light-measurement program or a subroutine incorporated into existing applications programs. The software can display light levels in foot-candles, lumens, or phots.

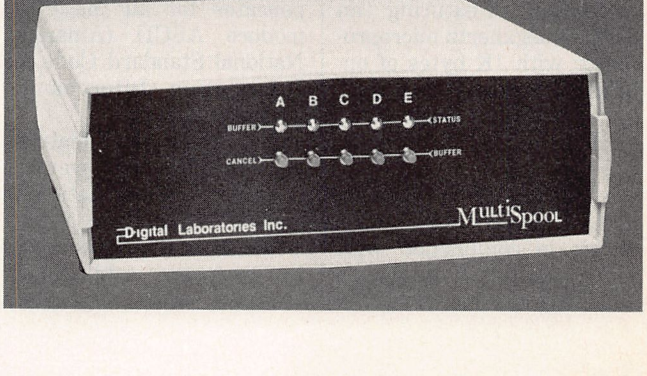
To find out more, contact Muirhead Inc., 1101 Bristol Rd., Mountainside, NJ 07092.
Circle 208 on inquiry card.

Spool Days

The Digital Multispool is a 64K-byte buffer that lets up to five computers share a single printer or one computer use multiple printers. Featuring an automatic-memory technique that allocates spool storage between devices, the unit sequentially scans each of its ports to permit instant, simultaneous access by several devices.

Compatible with all popular printers and computers, the Multispool uses a Z80 microprocessor, 64K bytes of dynamic random-access memory, 8K bytes of read-only memory, four UART (universal asynchronous receiver/transmitter) channels, and two parallel 8-bit ports. A series of light-emitting diodes provides a visual status check. Models are available with a wide selection of ports and other features. Prices of the Multispool range from $595 to $995, depending upon configuration.

More details are available from Digital Laboratories Inc., 600 Pleasant St., Watertown, MA 02172.
Circle 209 on inquiry card.



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The VisiWord™ program for the IBM® Personal Computer can help you make the most of every writing opportunity. It's available for both the IBM PC and the IBM XT with hard disk.

You'll write more effectively with the VisiWord program, because it's designed with the needs of the business professional in mind. It will also help you and your staff work more productively, because the VisiWord program has all the word processing functions your secretary or assistant needs.

You'll find the VisiWord program easy to learn, simple to use. And everytime you use it, you'll be pleased by how much less effort it takes to produce memos, letters, proposals and reports that reflect your very best efforts.

Writing, editing and printing your thoughts are done in a single process that's fast—without waiting for typing and retyping. And your results may be even more professional-looking because what you see on your screen is exactly what you get in your final printed result.

Easy to learn.

You're ready to write the instant the program is loaded. A simple, uncluttered screen display presents a multiple choice "menu" of functions.

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A QuickStart™ course is included to get you or anyone on your staff producing letters and reports within 30 minutes.

Even easier to use.

There are no hard-to-use "control" characters. A single keystroke selects all primary program functions—Insert, Delete, Copy, Move, Find/Replace, Storage and Print.

The most-used editing functions are also easy-to-use, because they're done with a single Function Key. These include Center Line, Underline, Delete, Delete To End Of Line, Undelete, Indent, New Page, Decimal Tab and Again.

Dynamic full page formatting lets you see instantaneously on the screen exactly what you'll get on paper. "Word wrap" is automatic for both creating and editing documents.

Additionally, time-saving "help" screens, and a clear, concise User's Guide in plain English give you the assistance you need at a glance.

More powerful editing with much less effort.

The VisiWord program lets you move, copy, or delete columns of information as well as paragraphs, and even pages, simply and easily.

It helps you make your documents look more professional by automatically formatting and numbering each page, and adding headers and footers if you wish.

And the VisiWord program's split screen windowing function lets you see two documents at once, and take parts of one and incorporate them into the other.

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The "print spooling" feature of the VisiWord program will save you important time by letting you print out one letter-perfect document at the same time you're creating another on your screen.

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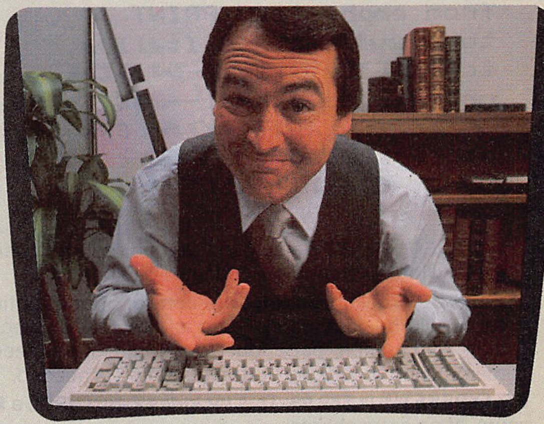

VisiWord!

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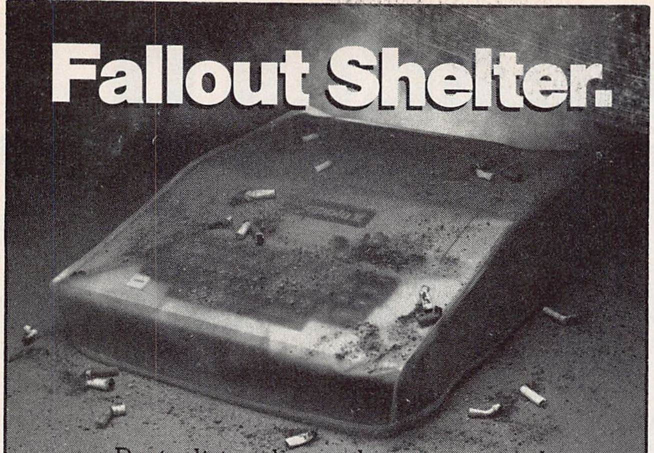

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Having trouble loading cassette-based programs into your Sinclair ZX81 or Timex/Sinclair 1000 microcomputer? With the Z-Dubber interface ($29.95) between your cassette recorder and computer, even the most reluctant program loads easily. The Z-Dubber will also connect two recorders to create masters and backups simultaneously.

The Z-Dubber operates on two AAA cells and is packaged in an attractive black case. For more information, write Bytesize Computer Products, POB 21123, Seattle, WA 98111.

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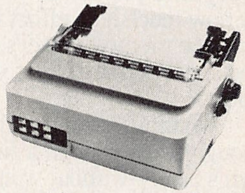
Versatile Printer



A low-cost 160 character-per-second (cps) dot-matrix printer is now available from Mannesmann Tally. Suitable for word processing, data processing, and graphics, the MT 160 offers dual-mode operation that prints both correspondence-quality and high-speed data-processing text.

The 80-column impact printer features a high-density 40 by 18 dot-matrix character printed at 40 cps; the data-processing mode uses a 9 by 7 dot-matrix character for a speed of 160 cps. The data-processing mode also features bidirectional, logic-seeking print head travel.

For word processing, the MT 160 has built-in software that provides letter-quality characters, proportional spacing, margin justification, automatic centering, and daisy-wheel code compatibility.

The MT 160 offers dot-addressable graphics for producing images you create on a video screen. In addition, the MT 160 can print 4 double-wide and 3 compressed-print character pitches plus the standard 10 characters per inch.

For versatility in paper handling, the printer offers friction feed for letterhead and cut sheets and clip-on attachments for fanfold forms or continuous-roll paper. The MT 160 also provides such conveniences as a long-life print head and a snap-in ribbon cartridge. A programming switch lets you select the operating mode by answering yes or no to a series of questions that the machine automatically prints. List prices for the MT 160 begin at $845.

For further information, write Mannesmann Tally, 8301 South 180th St., Kent, WA 98032.

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Hard Disks for the Apple II

The Datafile from Thought Works is a series of 5-, 10-, and 20-megabyte hard-disk drives for the Apple II. Each unit is a complete Winchester-type subsystem that includes power supply, cabinet, software, and intelligent controller.

Datafile drives support three popular operating systems: ADOS, CP/M, and Pascal. A Datafile connects to any Apple II without the need for hard wiring; you simply install an interface board in any available input/output slot and connect the two units with a ribbon cable. Complete assembly or disassembly requires only a few minutes. Prices range from $2995 to $3950.

For more details, write Thought Works, 3532 West Thomas Rd., Phoenix, AZ 85019.

Circle 212 on inquiry card.

Crafting Comfort

Valley Craft has introduced a microcomputer work center designed to organize computer components and promote maximum user comfort. The $190 system features an upper shelf that places the computer's monitor screen in an optimum viewing position and a slotted lower shelf for holding user manuals and other bulky items. A disk-drive rack keeps drives out of the way but easily accessible. Four hooded casters make the unit easy to move over carpeting or hard surfaces.

Details are available from Valley Craft Inc., South Highway 61, Lake City, MN 55041.

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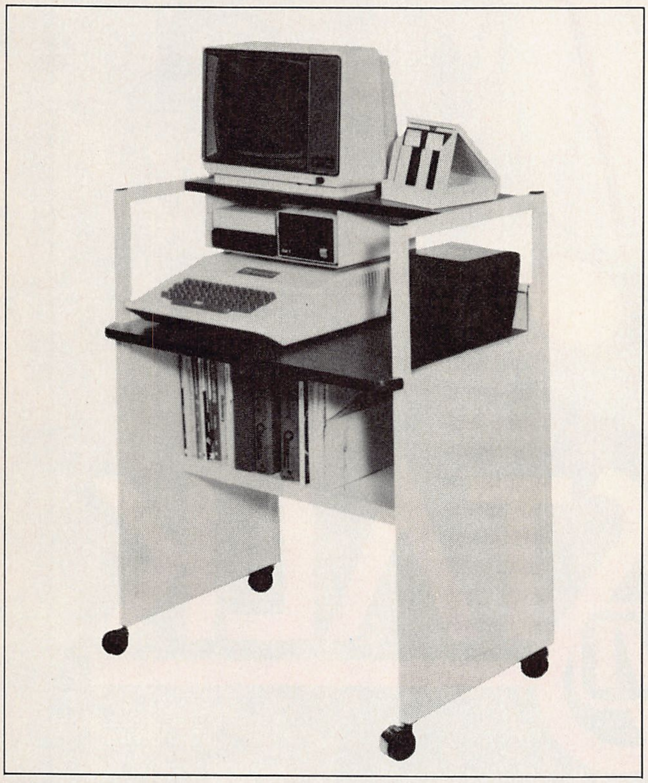
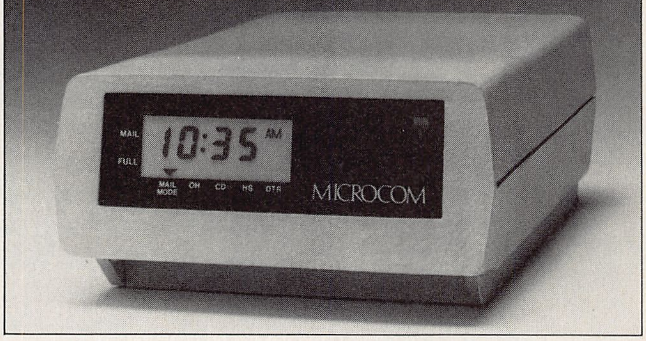


Valley Craft's microcomputer work center.

Processing Communications



Microcom's full-featured communications processor.

The Professional Communications System (PCS) is a "communications processor" that includes a 300- or 1200-bit-per-second (bps) modem and a message buffer containing up to 64K bytes of random-access memory (RAM).

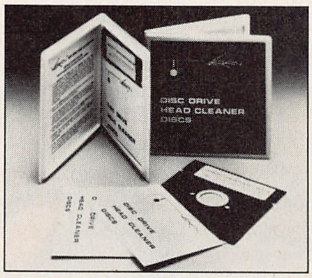
Designed primarily for use by medium to large corporations or by individuals who want to share files with other computer users, databases, or public information utilities, PCS provides unattended, scheduled, error-free message reception and transmission even while the computer is engaged in another application. In addition to its communications capabilities, PCS provides a user-configurable printer buffer, simultaneous printing and display of received information, and an LCD (liquid-crystal display) time-of-day clock. PCS has all other features of an intelligent modem, including stored-number capability.

PCS is available in four different versions. The PCS 1200-bps version has a retail price of $995 with 16K-byte RAM or $1095 with 64K-byte RAM. The PCS 300-bps unit costs $595 with 16K-byte RAM, $695 with 64K-byte RAM.

Further information is available from Microcom Inc., 1400A Providence Hwy., Norwood, MA 02062.

Circle 214 on inquiry card.

Cleaner Heads in 20 Seconds



Zolman International's Verfin Head Cleaner Disc is a 20-second, dry disk-drive head-cleaning system that absorbs contaminants into a nonabrasive polyester material.

Available in 5¼- and 8-inch sizes, the disks are compatible with all popular drives. You can use a pair of disks for 30 cleanings with a single-sided drive and for 15 cleanings with a double-sided unit. According to the manufacturer, the nonchemical Verfin product has the advantage over competitive wet products by being safer, easier to use, and handier to store. Two Verfin disks packaged in a protective plastic folder cost $24.95.

More information about Verfin disks is available from Zolman International Inc., 45th Floor, 600 Montgomery St., San Francisco, CA 94111.

Circle 215 on inquiry card.

For Roving Computerists

The Rover I is a portable computer that features compatibility with many Apple software packages, dual 8-bit microprocessors that let you run multiple programs simultaneously, 128K bytes of random-access memory, a full-travel keyboard with 10 function keys, an RS-232C communications interface, a parallel interface, and a real-time clock. The entire system—including the microprocessor, Rover display unit, 125K-byte miniature tape cartridge drive, and multifunction expansion unit—fits into a conventional attache case.

The Rover I and display unit provide a high-resolution graphics display on a 5½-inch green screen. Because the screen is entirely bit mapped, character fonts and display formats are completely definable in software. The high-resolution display is especially suitable for the presentation of business graphics.

The Rover's multifunction expansion unit comes in three models. The first type is designed for users who place a premium on portability. It contains a rechargeable battery pack that can power the Rover I and display unit for up to six hours of continuous operation. An optional modem lets you transfer data over telephone lines. The second model contains one or two 5¼-inch floppy-disk drives. These drives accept software written on disks compatible with Apple DOS (disk operating system) 3.3. The third model uses a 5-megabyte Winchester hard disk and one 5¼-inch floppy drive. Rover system prices start at $1800.

Software packages supplied with the Rover I include word processing/communications (Rextex), spreadsheet forecasting (Abacalc), and an advanced calculator program (Abacus). The Rover operating system (ROSY) lets you adapt or create your own software using commands very similar to those of Apple DOS 3.3 and Applesoft BASIC.

For complete information on the Rover system, write to M. P. Computer Systems Corp., POB 2396 Encinal Station, Sunnyvale, CA 94087.
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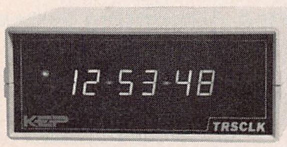
Have a Real Time



KEP's TRS/CLK is a real-time clock/calendar for the TRS-80 Model III computer. Available either with or without an LED (light-emitting diode) display, the TRS/CLK keeps track of the time and date during AC power outages for up to one year, thanks to a pair of internal penlight batteries. The KEP clock keeps time accurately to within 10 seconds per month.

The TRS/CLK comes with software that's compatible with all major operating systems. The unit connects to the Model III via the computer's input/output (I/O) bus. The clock includes a daisy-chain output for connecting other peripherals that use the same I/O bus, and a time set prevents accidental resets of time and data.

The TRS/CLK retails for $199.95 with display, $129.95 without display.

For further information, write to Kessler-Ellis Products Co., 120 First Ave., Atlantic Highlands, NJ 07716.
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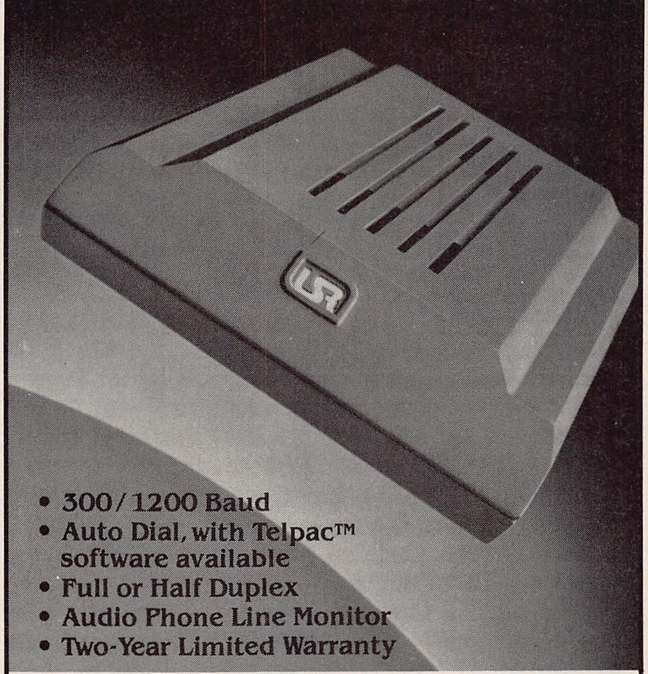

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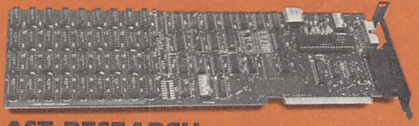

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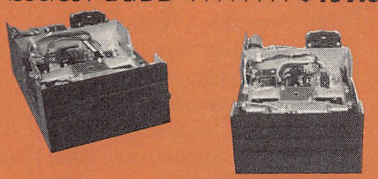

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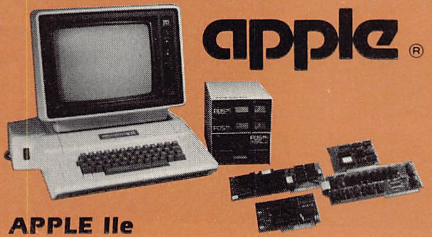

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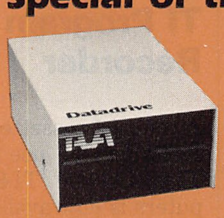

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80 Column Card	**$149**

HAYES MICROCOMPUTER PRODUCTS

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PERSONAL ACCOUNTANT
Software for your Apple IIe and Apple II+. **$199.00**

EPD PRODUCTS

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Lime Surge Protector	**$79.95**
Peach Surge Protector	**$89.95**
Orange Surge Protector	**$129.95**
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DEC Rainbow 100
Keybaord, CPU, Z-80/8088, 64K, Serial RS232 Port, Two X-400KB Disk Drives, Monitor, CP/M86®/80 Software, **CALL**

COMMSOFT PHOTOCASTER
Features a packed system to take, process, store, print, send and receive color and black and white photos with your Apple II computer.

PC 100 Disk software, I/O board, manual, demo tape **$499.95**

PC 101 All the above plus Panasonic TV Camera, RGB filter accessory **$749.95**

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COMPUSHACK

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	San Ramon	(415) 838-2233
	Tustin	(714) 730-7227
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Idaho	Twin Falls	★
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ALL FLOPPIES REPAIRED QUICKLY AT LOW COST

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HEADQUARTERS/TELEX: 181667—ANSWER BACK: COMPDSHACK IRIN**

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Circle 25 on inquiry card.

Jogging Memory

JC Computer Specialists has released the Memory Jogger, a programmer's aid for the IBM PC.

An 8½- by 14-inch BASIC reference card, the Memory Jogger describes all of the IBM's commands, statements, functions, and alternate keys. Suggested list price is $10 (plus $1.25 for postage and handling).

For additional information on the easel-mounted memory jogger, contact JC Computer Specialists, POB 3465, Federal Way, WA 98003.
Circle 218 on inquiry card.

Bumperware

This latest computer product doesn't go on top of your desk or into your disk drive. Instead, you apply it to any flat, clean surface.

Bumperware 1.0 is an adhesive piece of vinyl with the message "I'd Rather Be Programming" printed on it. It's suitable for the contented computer enthusiast's car, office, or home. Printed in big red letters on a clean white background, the eye-catching 3¾- by 11½-inch stickers cost $2 for one and $1 for each additional sticker, including tax and postage.

You can order Bumperware 1.0 from Opcode Software, 1909½ Vine St., Berkeley, CA 94709.
Circle 222 on inquiry card.

Of the User, By the User, For the User

Here's a book for Visicalc owners. *Visicalc—By the User for the User* is a collection of the best material culled from *Spreadsheet*, the international newsletter of Visicalc fans.

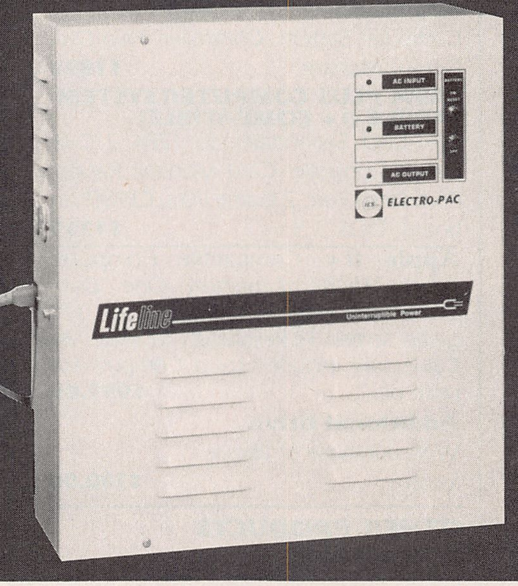
Aimed to appeal to electronic-spreadsheet beginners and pros, the book features dozens of programs, tips, and how-to articles. Included are articles on template formatting and planning, spreadsheet peripherals, a Visicalc file-reading program, and a mini-general-ledger instruction set.

Visicalc—By the User for the User is available for $10 from the Intercalc Users Group, POB 4289, Stamford, CT 06907.
Circle 219 on inquiry card.

Fail-Safe Power for Computers

The 600VA Lifeline uninterruptible AC power system provides 5 amps of noise-free 120-volt power to computers, disk systems, communications terminals, and other equipment. Designed for easy installation, the $1435 unit connects to any standard 120-volt wall outlet. A maintenance-free battery (not included) can provide up to 10 minutes of emergency power.

More details are available from ICS Inc., Electro-Pac Division, 520 Interstate Rd., Addison, IL 60101.
Circle 221 on inquiry card.



The Computing Lawyer

Attorneys Computer Report is the first newsletter about computers written for lawyers. Published biweekly, the newsletter features information on computer equipment and software available to lawyers, as well as information from users on how well specific products work in law practices. *Attorneys Computer Report* also tells lawyers how they can use computers to cut costs, better manage their practices, and expand services to clients.

An annual subscription to *Attorneys Computer Report* costs $229. For further information and a free sample, write to Professional Publications Inc., POB 80280, Atlanta, GA 30366.
Circle 223 on inquiry card.

Apple Joyport

Apple II users can now expand their computer's paddle port to accommodate four fully functional Apple-compatible paddles and two Atari-type joysticks.

The $49.95 Joyport eliminates the need to open the Apple case to switch game input devices. Atari-type sockets are mounted on the front of the Joyport, and Apple game sockets are easily accessible under a convenient snap-on cover. External Joyport switches let you select active inputs. The Apple needs no modification whatsoever.

Each Joyport comes with complete documentation, installation instructions, and listings for BASIC and Pascal interface programs. Additional details are available from Sirius Software Inc., 10364 Rockingham Dr., Sacramento, CA 95827.
Circle 220 on inquiry card.

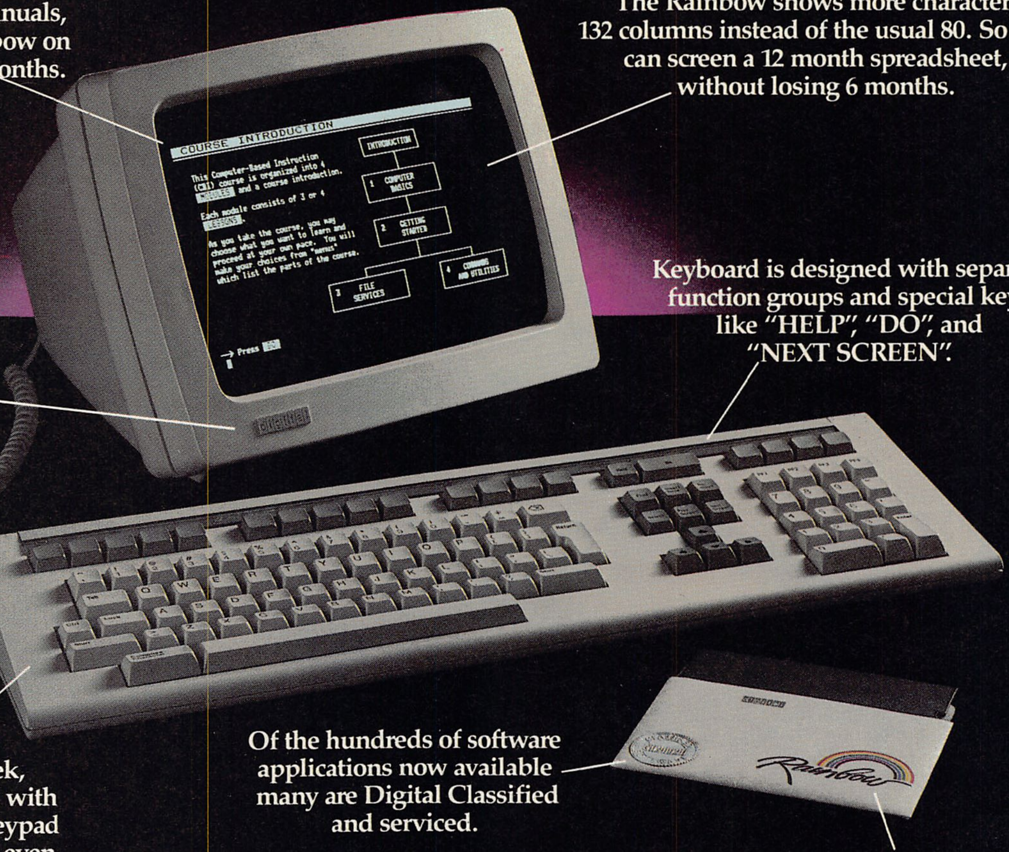
TI Program Recorder

A compact cassette Program Recorder for use with the TI-99/4A and TI-99/2 computers is now available from Texas Instruments.

The Program Recorder features automatic level control (ALC), a digital tape counter, clearly marked optimum settings for volume and tone control, color-coded input jacks, a pause control, and a built-in microphone. The Program Recorder package ($69.95) includes an interface cable for the TI-99/4A (the TI-99/2 comes equipped with an interface cable). The recorder operates off four C-size batteries or through an AC power adapter included with the package.

More information can be obtained from Texas Instruments, Lubbock, TX 79408.
Circle 224 on inquiry card.

Look over the Rainbow.



COURSE INTRODUCTION

This Computer-Based Instruction (CBI) course is organized into 4 MODULES and a course introduction.

Each module consists of 3 or 4 LESSONS.

As you take the course, you may choose what you want to learn and proceed at your own pace. You will make your choices from "menus" which list the parts of the course.

→ Press DO

Learn Rainbow™ computer-based instruction ends manual labor. No slaving over computer manuals, you learn to use the Rainbow on screen, in minutes, not months.

The Rainbow shows more character, 132 columns instead of the usual 80. So you can screen a 12 month spreadsheet, without losing 6 months.

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Only the Rainbow automatically runs the widest range of the popular 8-bit *and* 16-bit CP/M® software.

After you look over the Rainbow™ personal computer on paper, look over the Rainbow in person. To learn where, call 1-800-DIGITAL or write **Digital Equipment Corporation**, 200 Baker Avenue, Concord, MA 01742.

Not even the world's largest computer company gives you so much. But the second largest does.

digital

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How to quickly re

If you'd like to turn the agony of small business bookkeeping into the ecstasy of total control, you've come to the right place.

Because even if you're starting with a shoe box full of invoices or a pile of checks hiding under a pile of deposit slips, we can tell you how to centralize, organize and monitor all that information, and manipulate it in ways that will make your business a pleasure—all with an Apple® III Personal Computer.

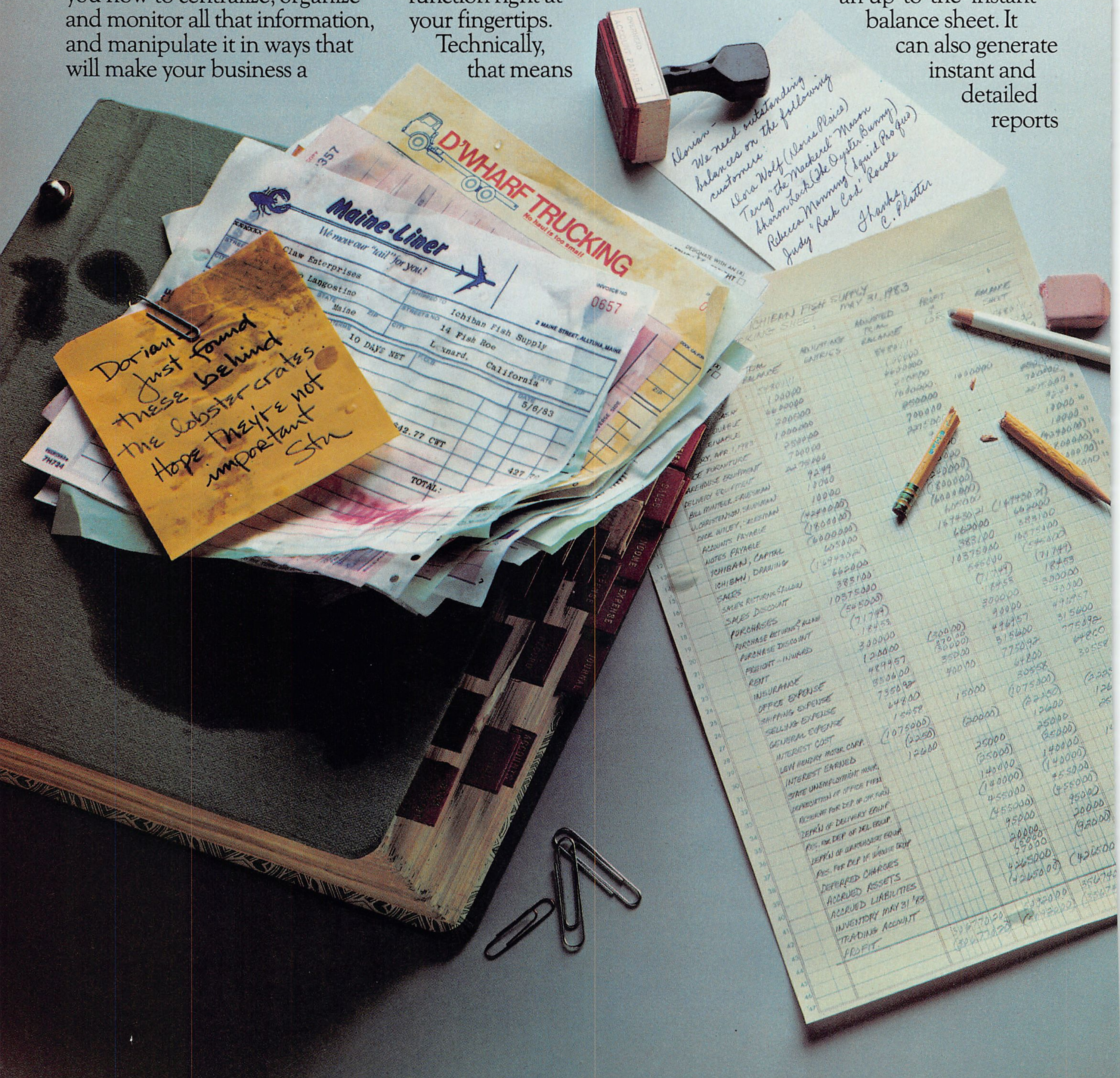
Attain instant financial status.

An Apple III, teamed with the BPI General Accounting Package, can put every basic accounting function right at your fingertips.

Technically, that means General Ledger, Accounts Payable, Accounts Receivable and Payroll—all in one package.

Meaningfully, that means you can turn numbers into answers.

With BPI, your Apple III can give you a snapshot of your company's financial condition, an up-to-the-instant balance sheet. It can also generate instant and detailed reports


Dorian- Just found these behind the lobster crates. Hope they're not important Stu
Dorian - We need outstanding balances on the following customers: Ilona Wolf (Ilona's Place) Terry "the Mackerel" Mason Sharon Lock (The Oyster Bunny) Rebecca Manning (Squid Pro Quo) Judy 'Rock Cod' Rocole Thanks C. Platter
D'WHARF TRUCKING
No haul is too small
Maine-Liner
We move our "tail" for you!
Ichiban Fish Supply
14 Fish Roe
Oxnard, California
10 DAYS NET
5/6/83
0657
ICHIBAN FISH SUPPLY MAY 31, 1983
ACCOUNTS PAYABLE

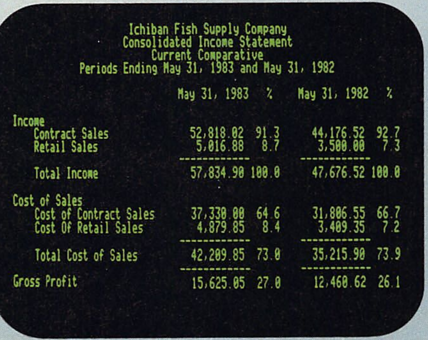
gain your balance.

on your customers and vendors.

So you know who owes whom, how much, and how come.

And just how well your cash flow is flowing.

And where to give credit where credit is due (a customer inquiry feature allows you to make credit decisions based on the most current information).



```
              Ichiban Fish Supply Company
             Consolidated Income Statement
                  Current Comparative
       Periods Ending May 31, 1983 and May 31, 1982

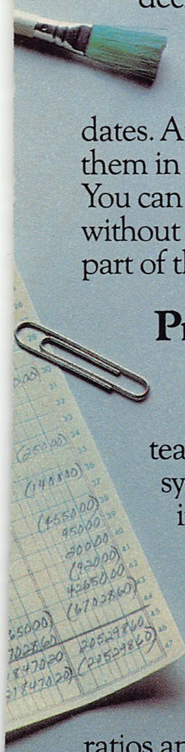
                          May 31, 1983   %    May 31, 1982   %

Income
   Contract Sales          52,818.02  91.3    44,176.52  92.7
   Retail Sales             5,016.88   8.7     3,500.00   7.3
                          ------------        ------------
   Total Income            57,834.90 100.0    47,676.52 100.0

Cost of Sales
   Cost of Contract Sales  37,330.00  64.6    31,806.55  66.7
   Cost Of Retail Sales     4,879.85   8.4     3,409.35   7.2
                          ------------        ------------
   Total Cost of Sales     42,209.85  73.0    35,215.90  73.9
                          ------------        ------------
Gross Profit               15,625.05  27.0    12,460.62  26.1
```

Your Apple can generate instant income statements (with expense ratios) or balance sheets, and let you compare them to last month's or year's, then print them out to suit your banker.

You can also list your purchases by discount dates. And take advantage of them in no uncertain net terms. You can even keep payroll records without paying more, because it's part of the same package.



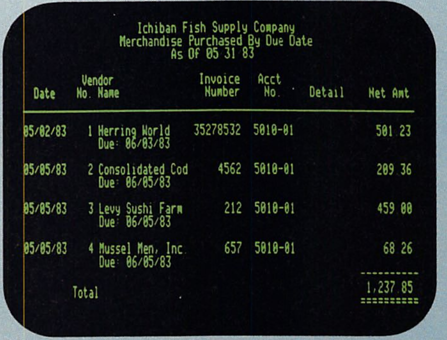
Profit from history.

In business as in life, experience is the best teacher. And the Apple/BPI system can provide you with instant comparisons of this-month-this-year vs. this-month-last-year, or this-year-to-date vs. last-year-to-date.

So you can quickly spot changing expense ratios and make decisions with 20/20 foresight.

The BPI General Accounting Package also lets your income statements be coded by location, department or product line. So you know where your money's coming from.

And where it's not.



```
                Ichiban Fish Supply Company
              Merchandise Purchased By Due Date
                      As Of 05 31 83

         Vendor                Invoice   Acct
Date     No. Name              Number    No.      Detail    Net Amt
--------------------------------------------------------------------
05/02/83  1 Herring World     35278532  5010-01              501.23
            Due: 06/03/83

05/05/83  2 Consolidated Cod      4562  5010-01              209.36
            Due: 06/05/83

05/05/83  3 Levy Sushi Farm        212  5010-01              459.00
            Due: 06/05/83

05/05/83  4 Mussel Men, Inc.       657  5010-01               68.26
            Due: 06/05/83
                                                          ----------
           Total                                           1,237.85
                                                          ==========
```

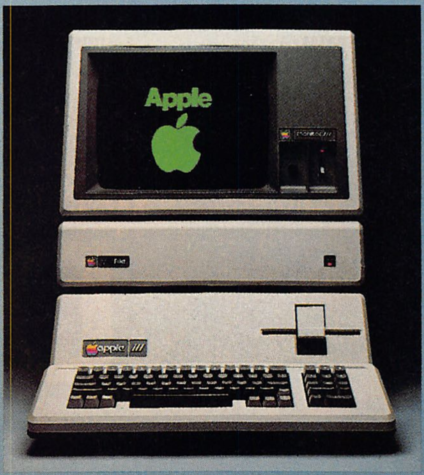
It can also allow you to take full advantage of merchandise discounts. So you'll know whom to pay, when to pay, how much to pay—and save a lot of clams in the process.

Make a timely statement.

Add an Apple Dot Matrix or Daisywheel printer to your Apple III, and you can print out your entire balance sheet in minutes.

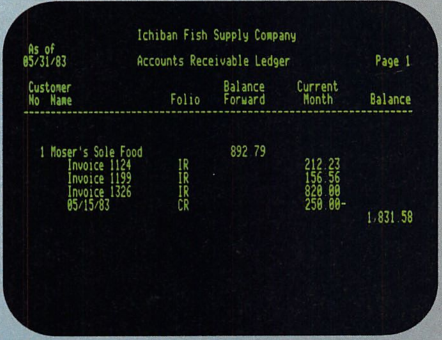
Or any number of reports, from cash receipts to payroll ledger to income. You can even print checks and customer statements.

The impressively professional results will make an important statement to everyone you deal with—including your banker.



More ways Apples pay.

There are more people in more places doing more things with Apples than with any other personal computer in the world.



```
                      Ichiban Fish Supply Company
As of
05/31/83              Accounts Receivable Ledger                 Page 1

Customer                               Balance    Current
No  Name                     Folio     Forward     Month        Balance
-----------------------------------------------------------------------


  1 Moser's Sole Food                   892.79
       Invoice 1124          IR                   212.23
       Invoice 1199          IR                   156.56
       Invoice 1326          IR                   820.00
       05/15/83              CR                   250.00-
                                                               1,831.58
```

To avoid fishy transactions, you can instantly display customer's payments, charges and current balance. In this case, a few more cans of tuna would put Mr. Moser over his $2,000 limit.

Because for one thing, there's more software for Apples than for any other personal computer in the world. So the same Apple that handles all your accounting needs can also handle financial spreadsheets, word processing and electronic filing.

You'll also find programs that are designed specifically for your kind of business. Be it dentistry, architecture or swine herding.

Of course, the best way to learn all the ways Apples can help you make better business decisions is to visit any one of over 1500 authorized Apple dealers.

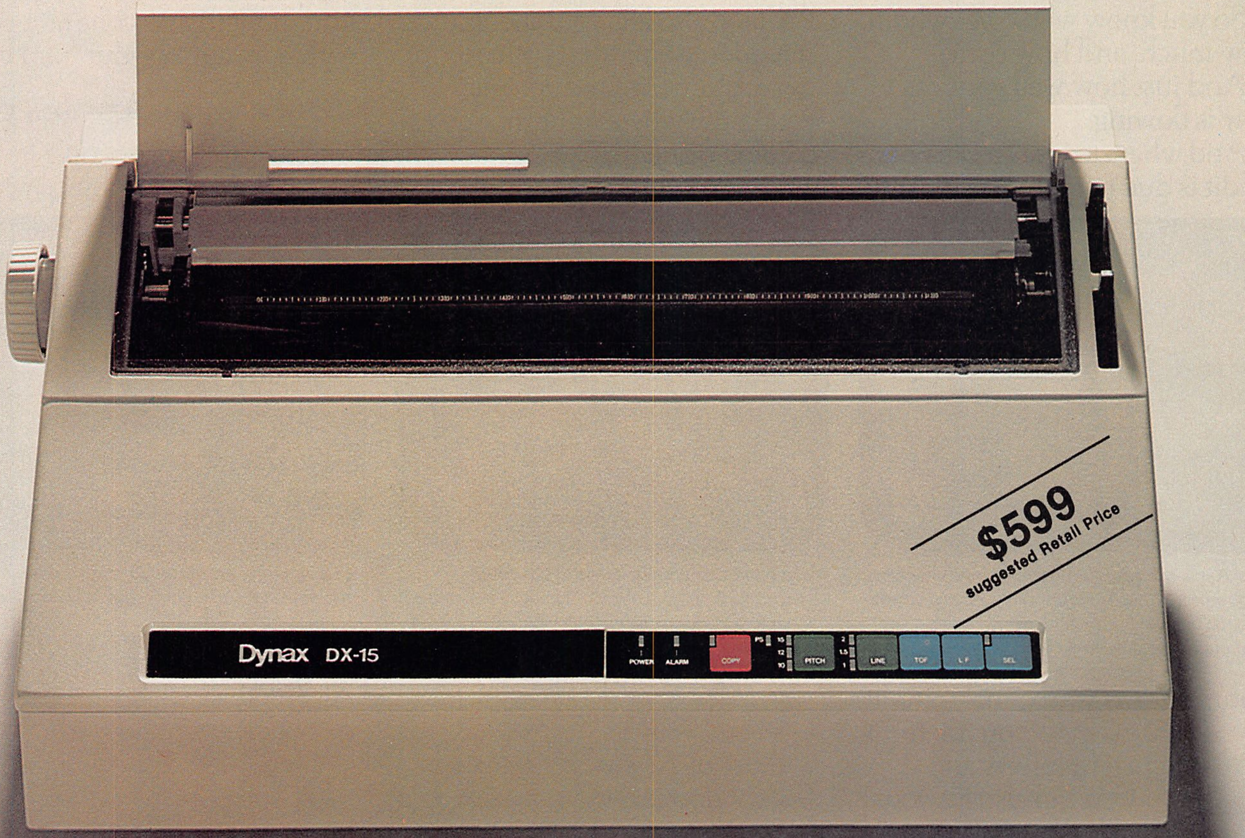
So drop in. For a full account.

apple®

Call **(800) 538-9696** for the location of the authorized Apple dealer nearest you, or for information regarding our National Account Program. In Canada, call (800) 268-7796 or (800) 268-7637. Or write Apple Computer Inc., Advertising and Promotion Dept., 20525 Mariani Ave., Cupertino, CA 95014. © 1983 Apple Computer Inc.

Circle 7 on inquiry card.

DYNAMITE



$599
suggested Retail Price

The Dynax DX-15 explodes into the eighties as the most advanced letter-quality printer on the market today. Complete with all the sophisticated features found in your costlier models, and offering such options as Key Board, Tractor Feed, and Auto Cut Sheet Feed, the DX-15 assures the user, whether it be for business, home or word processing applications, the ultimate in reliability and durability at a blow-away price.

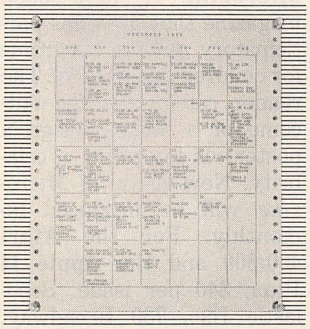
The DX-15 won't blow your budget either, but it will blow the myth that a printer with all these advanced features has to be expensive. Visit or call your nearest dealer for full particulars and let us blow your mind at how inexpensive it is to put you behind the printer of the eighties, **the Dynax DX-15... It's Dynamite.**

Dynax

DYNAX INC. 5698 Bandini Blvd., Bell, CA 90201

Business

Calendar/1—A program that allows you to produce a personal or business calendar on a terminal or printer. This program will sort and merge the dates and events you input and can be tailored to meet the needs of an individual or entire organization. For **CP/M-80-based** systems with 52K bytes of memory; $60. Clear Systems, 309 Santa Monica Blvd., Santa Monica, CA 90401.



Energraphics—A graphics package that produces business graphics, flow charts, and statistical plots and other general drawing functions. This program can construct two-dimensional line and pie charts and three-dimensional bar charts. Graphics can be saved and reproduced for editing, rotating, zooming, hidden line removal, or text addition. For the **IBM Personal Computer** with 64K bytes of memory; $250. Enertronics Research Inc., Suite 207, 150 North Meramec, St. Louis, MO 63105.

Farm Account—A bookkeeping system for farmers that monitors income and expenses and lists items by code or name. Net income schedules can be printed for end-of-year planning, and all entries can be modified or corrected at any time. Requires 32K bytes of memory and an 80-column printer. For the Radio Shack **TRS-80 Model III**; $99.95. Fred's Micro-Ware, Route 1, Box 162, Amboy, MN 56010.

FYI5000—A multifunction program that performs word processing, database management, and mailing-list operations. FYI5000 can update entries, print letters and labels, merge and split files, retrieve files, and perform keyword searches. Includes a spreadsheet, spelling checker, a communications program, and an appointment calendar. Requires PC-DOS 1.1, 64K bytes of memory, and two floppy-disk drives or a hard disk; for the **IBM Personal Computer**; $495. FYI Inc., POB 26481, Austin, TX 78755.

Gold Series III—A business accounting package designed for multiple profit centers, multistate payrolls, and multiple jobs. Included are general ledger, accounts payable, accounts receivable, payroll, job costing, order entry/invoicing, and inventory. For the **IBM Personal Computer** and **CP/M-86-based** systems; $695 to $1195 per application. Gold Software, 906 North Main, Wichita, KS 67203.

Graph 'N' Calc—An easy-to-use business graphic generator and statistical analysis program. This menu-driven system includes a set of commonly used statistical and financial calculations and produces stacked and side-by-side bar, line, and pie charts. For the **Apple III** with 256K bytes of memory and the **IBM Personal Computer** with 64K bytes of memory; $199. Desktop Computer Software, Building 29, Suite 303, 303 Potrero St., Santa Cruz, CA 95060.

Office Filer—A database manager that lets you create files using a fill-in-the-blank format for data entry. All completed files can be password-protected and user-defined reports can be generated. For the **IBM Personal Computer** with 128K bytes of memory; $395. Digital Marketing Corp., Suite 8, 2363 Boulevard Circle, Walnut Creek, CA 94595.

Powerbase—A database manager featuring fast search, sort, and select. It provides sounds-like retrieval, a front-end editor, and the ability to handle arithmetic expressions written in algebraic form. A Datazoom feature lets you focus on detailed components of specific information. For the **IBM Personal Computer**; $475. GMS Systems Inc., 12 West 37th St., New York, NY 10018.

power-base
with datazoom
A relational/hierarchical database management system
gms systems inc.

The Prospect Manager—A program designed for sales personnel that keeps track of clients and maintains such information as name, address, telephone number, type of lead, and last contact date. The system has a built-in direct-mail feature for producing labels and form letters. For the **IBM Personal Computer**; $129. Automated Information Systems, Suite 203, 1503 Ave. J, Lubbock, TX 79401.

Small Fortune Auto-Ledger—A general-ledger package that has the ability to accommodate several hundred income, expense, asset, liability, and capital accounts. This program allows you to budget your expenses on a monthly, quarterly, or year-to-date basis and features a report module. Requires an 80-column display. For the **IBM Personal Computer** with 64K bytes of memory; $199.95. A compiled version requiring 64K bytes of memory costs $250. Emerald Software Inc., 2416 Warren Ave. N, Seattle, WA 98109.

Games

Bulls and Cleots—An elimination game in which you try to guess a four-digit number before your opponent does. Clues are given after each turn. You may play by yourself, with a friend, or against the computer. Three levels of play. For the **Atari 400/800** with 32K bytes of memory; floppy disk or cassette, $25 and $20, respectively. Thesis, POB 147-C, Garden City, MI 48135.

New Software provides up-to-date listings of the latest releases in microcomputer software, grouped into seven categories: Business, Games, Home, Education, Programming Languages, Word Processing, and Technical Tools. New Software listings are based on product information supplied by the manufacturers and should not be considered endorsements of the products listed. For in-depth evaluations of the most important and interesting new releases, read our Software Review section.

Caves of Zulu—A fully animated graphics adventure game that takes you on a journey in which you try to avoid falling into a pit or the attack of ferocious creatures. For the **Timex/Sinclair 1000** with 8K bytes of memory and the Sinclair **ZX80/81** with 16K bytes of memory; $19.95. Stuart Software, Suite 316, 25381-G Alicia Parkway, Laguna Hills, CA 92653.

Collision!—An arcade-type game in which you try to maneuver a growing line on the screen, avoiding the walls and other obstacles while attempting to make your opponent crash. Nine levels of difficulty. For the **Commodore 64**; floppy disk or cassette, $15.95 and $12.95, respectively. Topologic, POB 752, Burlington, IA 52601.

Epidemic—An adventure game that charges you with putting a stop to the most virulent epidemic ever known. As director of the Center for Disease Control, you have at your disposal clean suits, X-rays, interferon, vaccines, gene splicing, and microwaves. If all these fail, you can destroy an area in which the disease is totally beyond control. For the **Apple II Plus, Apple III,** and **IBM Personal Computer** with color graphics board; $39.95. Strategic Simulations Inc., Suite 108, 465 Fairchild Dr., Mountain View, CA 94043.

In Search of the Most Amazing Thing—An adventure game that features color, music, and animation. To begin the journey, each player must seek the advice of Old Smoke Bailey, who explains what the player might encounter on his or her search. The player must obtain food, fuel, fly a B-liner through storms, communicate with foreign cultures and avoid the dangerous Mire Crabs. For the **Apple II Plus** and **IIe, Atari 400/800** and **1200, IBM Personal Computer,** and **Commodore 64**; $39.95. Spinnaker Software, 215 First St., Cambridge, MA 02142.

IN SEARCH OF THE MOST AMAZING THING
BY TOM SNYDER PRODUCTIONS
SPINNAKER

Lazer Maze—An adventure game set in the 24th century where warfare has become obsolete. To settle your dispute, you meet your opponent in the Arena of Final Reconciliation in a one-on-one competition. Surrounded by mirrors, you must fire your lazer gun and predict where the beam will exit after reflecting off the walls. For the **Apple II Plus** and the **IBM Personal Computer** with a color graphics board; $29.95. Avant-Garde Creations, POB 30160, Eugene, OR 97403.

Night Mission Pinball—An arcade-type pinball game based on a World War II night bombing mission. The program allows you to keep four balls in play at the same time and provides ten levels of play. For the **IBM Personal Computer** with 64K bytes of memory and a color graphics board; $39.95. Sublogic Corp., 713 Edgebrook Dr., Champaign, IL 61820.

Super Battle—An arcade-type game. The object of this game is to be the first player to sink all your enemy's ships. The computer keeps score of all hits. For the **Apple II** with 48K bytes of memory; $28. Super Systems Inc., Drawer 1390, Fort Myers, FL 33902.

Supreme Ruler—Up to nine players participate as rulers of small, struggling countries. Players try to gain more power as the game progresses. As a ruler, you must make decisions affecting your nation directly and the outcome of the game. For the Radio Shack **TRS-80 Models I** and **III**; floppy disk or cassette, $20.50 and $18.50, respectively. JMG Software International, POB 598, Falls Station, Niagara Falls, NY 14303.

Education

Arithmatech—A mathematical program that provides addition, subtraction, multiplication, and division problems in varying degrees of difficulty. Aspects such as time allotment, number of problems, and level of difficulty are all user-defined. For the **Osborne 1**; $79. MC Services, POB 7835, Philadelphia, PA 19101.

Comsail I—A simulation of a 30-foot sailboat navigating a plotted course. Your performance is rated with a numerical score and is based on your ability to handle the rudder, main sail, jib, wind angle, and speed. Boat speed, elapsed time, and compass heading are displayed on the screen. For the **Apple II, II Plus,** and **IIe**; $59.95. Single Source Solution, 2637 Pleasant Hill Rd., Pleasant Hill, CA 94523.

Exams—A program that helps teachers create, modify, and store multiple-choice and true-or-false test questions. This program can accommodate tests with up to 100 questions with as many as five possible answers. Requires 32K bytes of memory, two disk drives, and a line printer. For the Radio Shack **TRS-80 Model III**; $69.95. Manual only, $12.95. Microsoftware Services, POB 776, Harrisonburg, VA 22801.

Math Invaders—A mathematical drill program set up in a game format. **Math Invaders** provides different levels of difficulty and is geared toward grades one through eight. For the **Apple II, II Plus, IIe,** and **III**; $39. Winners Circle Education, 1308 Temple Bldg., Rochester, NY 14604.

Managing Your Time—An educational utility program that helps you organize your time by identifying wasteful habits. It provides solutions for changing those habits into more productive activities. Daily schedules can be designed for hard-copy printout. For junior high school students and older. For the **Apple II**; $44.95. MCE Inc., Suite 250, 157 South Kalamazoo Mall, Kalamazoo, MI 49007.

Microzine—A disk-based magazine that provides participatory reading programs for children ages 8 to 14. The reader can decide the outcome of a story, design a poster, or interview a celebrity. New issues of *Microzine* will be produced bimonthly. For the **Atari 400/800** and the **Apple II Plus**; $40 per issue. Scholastic Inc., 730 Broadway, New York, NY 10003.

Minus Mission—A math game in which a child works to solve the math problems contained in attacking blobs of slime. Each time the child answers a problem correctly a robot on the screen is allowed to shoot and destroy the blobs. For the **TI-99/4A**; cartridge, $39.95. Texas Instruments, POB 10508, Lubbock, TX 79408.

Quotrix—An educational game in which you try to guess a famous quote using words obtained from crossword puzzles, trivia questions, foreign word translations, and word games. More than 600 quotes are contained in this program. For the **IBM Personal Computer**; $34.95. Insoft Inc., Suite 202B, 10175 Southwest Barbur Blvd., Portland, OR 97219.

The Skeletal System—A collection of programs covering five different parts of the body: bones, major skeletal bones, joints, ligaments, and cartilage. A review test is also included. For the **Commodore PET** and **Apple II, II Plus,** and **IIe;** floppy disk or cassette, $72. Brainbank Inc., 220 Fifth Ave., New York, NY 10001.

Solving the Mysteries of Science—A science program designed for students in grades seven through nine. This package is made up of ten general subjects, which are covered in two dozen lessons. Features include high-resolution graphics and positive reinforcement for all answers. For the **Apple II** and **IIe;** $39.95 per lesson; $850 for the complete 24-lesson series. Visual Materials Inc., 4170 Grove Ave., Gurnee, IL 60031.

The Visible Computer: 6502—A program that teaches you machine-language programming. It features high-resolution 6502 simulation and allows you to view a program as it is being executed. The speed at which the program runs is user-defined. For the **Apple II Plus** with 48K bytes of memory; $49.95. Software Masters, Suite BB, 3330 Hillcroft, Houston, TX 77057.

Word Attack!—A vocabulary-building program geared toward ages 8 through adult. Four separate exercises help you master more than 600 words, their meanings, and usage. For the **Apple II** and the **IBM Personal Computer;** $49.95. Davidson & Associates, 6069 Groveoak Place #12, Rancho Palos Verdes, CA 90274.

Your Personal Computer Tutor—An interactive program that teaches the computer novice how to operate the **IBM Personal Computer.** The lessons cover an introduction to computers, how to use the keyboard, information storage, DOS commands, how the computer works, and what software is. Monochrome or color monitors may be used. For the **IBM Personal Computer;** $75. Texasoft Inc., Suite 100, 3415 Westminster, Dallas, TX 75205.

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Financial Record Keeper—A personal record-keeping system that maintains and tracks a year's income and expenditures in 20 user-defined files. Also available is the **Financial Record Keeper Plus,** which does all the above and keeps track of bankbook and checkbook transactions. For the **Sinclair ZX80/81** with 16K and 48K bytes of memory, respectively. **Financial Record Keeper,** $14.99. **Financial Record Keeper Plus,** $24.99. Markel Software, POB 2392, Secaucus, NJ 07094.

Market Master: Dual Moving Average—The first program in a series of investment programs, **Dual Moving Average** lets you test a stock or commodity trading method to find its profit potential without risking any money. It determines buy and sell points according to the crossing of two moving averages and can print out recommendations for up to 100 stocks or commodities. For the Radio Shack **TRS-80 Models I and III;** $124.95. Management Services, 2901 Clendenen Lane, Longview, TX 75601.

Tax Hints—A program that helps you compute how much money you can deduct from federal taxes for your personal computer. **Tax Hints** will calculate depreciation, investment tax credit, or expenses when you use your computer for business,

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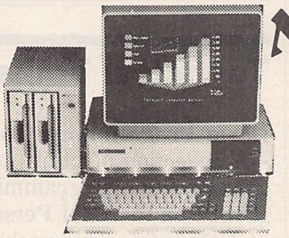

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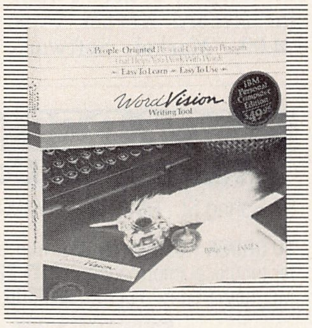
Letterbank—A word-processing applications package that provides you with more than 200 business letters relating to everyday transactions. These letters can be added to, subtracted from, or modified in any way to fit your specific needs. Three different versions of each subject are included. For the **Apple, TRS-80, IBM Personal Computer, Osborne** and **CP/M-based** systems; $99. The Wyndham Group Ltd., 125 Mirona Rd., Portsmouth, NH 03801.

Spellback—A spelling checker that contains a 50,000-word dictionary. This program displays the full line of text containing a misspelled word. You can create an auxiliary dictionary as a supplement to the permanent one. For the **IBM Personal Computer** and the **Sage II**; $125. Western Software Development, POB 953, Woodland Park, CO 80863.

Wordvision—An extensive word processor that allows you to control page formatting, including margins, number of lines per page, characters per line, and line spacing. **Wordvision** provides automatic page headings, footings, and numbering. For the **IBM Personal Computer**; $49.95. Bruce & James, 4500 Tuller Rd., Dublin, OH 43017.



Technical Tools

Basic Programming Tools—A collection of utility programs for programming BASIC on the **IBM Personal Computer**. This package provides a full-screen editor, automatic conversion of symbolic line labels to line numbers, cross-reference listings, and removal of remarks and blanks. For the **IBM Personal Computer**; $120. Synergistic Software, 830 North Riverside Dr., Renton, WA 98055.

Cross-Reference—A utility program that provides you with cross-reference information about a program under development. It can locate references to variables, arrays, BASIC commands, strings, and special symbols. For the Radio Shack **PC-2** and Sharp **PC-1500** pocket computers; $18.95. Pocketinfo Corp., POB 152, Beaverton, OR 97075.

EDM—A programmable file editor that handles nine file formats: ASCII, token, EDTASM, M-80, M-zal, machine code, Pencil format, line format, and unformatted "raw" disk-sector bytes. For the Radio Shack **TRS-80 Models I** and **III** with 48K bytes of memory; $149. The Alternate Source, 704 North Pennsylvania Ave., Lansing, MI 48906.

PC Create—An easy-to-use BASIC program generator that lets you build and maintain a random-access file according to your specifications. For the **Apple II** and the **IBM Personal Computer**; $50. Data Transport Systems Inc., 347 East 62nd St., New York, NY 10021.

Power—A menu-controlled user-interface that saves time by performing day-to-day operating chores. It allows you to transfer files without typing filenames and run programs from the numbered menu. For **CP/M-based** systems; $149. Computing!, 2519 Greenwich, San Francisco, CA 94123.

Print+Apple—A collection of printer programs that provide a number of print types for letterheads, addresses, file labels, and recipes. For **Epson MX80/100** printers with **Graftrax Plus** and the **Apple II Plus**; $24.95. Microwest Software, Suite 100, 868 North Second St., El Cajon, CA 92021.

Secure—A system designed to prevent unauthorized use of or entry to CP/M data files. This program uses a proprietary encryption technique that protects any confidential information stored in your computer or transmitted via data communications. For **Z80-based CP/M** systems; $150. Century Systems Inc., Suite 11B, 12872 Valley View Ave., Garden Grove, CA 92645.

Structured Program Translator—A system that lets you write programs in a structured language based on Pascal, then it translates them into MBASIC so that they can run on MBASIC-equipped computers. For **CP/M-80-based** systems; $29.95. Mastercomputing Inc., POB 17442, Greenville, SC 29606.

3DRB—A graphics program that lets you create high-resolution plots of three-dimensional figures, label graphs with ASCII English labels, experiment with red and blue stereoscopic displays that can be viewed with three-dimensional glasses, and animate three-dimensional figures. For the **Apple II**; $59. Metaresearch Inc. 1100 Southeast Woodward, Portland, OR 97202.

VC-Plus—A program that allows memory expansion of Visicorp's **Visicalc** as well as a choice of 40 or 80 columns of workspace. For the **Apple II**. This package is supplied with the purchase of Legend Industries' **128KDE, 64KC,** or **64KDE** RAM expansion cards or it's available as a $20 upgrade. Legend Industries Ltd., 2220 Scott Lake Rd., Pontiac, MI 48054.

Xenix—A multiuser operating system derived from Bell Laboratories' **Unix** that lets up to three people run programs simultaneously. Users can operate different programs or share the same data. Peripherals are shared by all users. For the **TRS-80 Model 16**; free to all **Model 16** owners. A separate development system, which includes the **C** language, is available for $750. Radio Shack, 1800 One Tandy Center, Fort Worth, TX 76102. □

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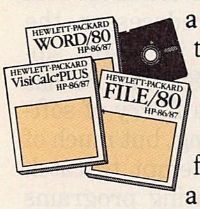

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How Invincible Is Big Blue?

The IBM PC is the sales pacesetter, but it hasn't set standards yet

by A. Richard Immel

Anyone who has ever touched a microcomputer knows that one of the most aggravating obstacles to using micros in business today is the absence of standards. It starts at the keyboard, which might be anything from a Selectric-style typewriter layout to a mind-numbing array of special-function keys that could barely fit on a church organ.

But that's just the beginning. Floppy disks come in what seems like a thousand different formats; operating systems are an alphabet soup (DOS, SOS, TRSDOS, CP/M, MS-DOS, and so on); and software that works on one system won't run on another—or sometimes not even on different models from the same manufacturer.

It would be heartening if I could report that the industry has come to its senses and is starting to formulate a coherent set of standards to make buying decisions a little easier. Sad to say, the situation is no better today than it was a year ago; in fact, it's getting worse. The latest battlefields are local networks (for wiring personal computers together) and a whole new family of pocket-sized floppy disks, which a number of companies feel compelled to shrink but can't agree by how much.

In the midst of this growing chaos there are some folks who think that "standards" of sorts are emerging in the wake of IBM's spectacularly successful entry into the microcomputer business. This possibility, in turn, raises some questions for the person who's trying to figure out what kind of microcomputer to buy for a small business: If I buy a computer today, will it be obsolete tomorrow? Do I need an IBM Personal Computer for insurance? How about IBM compatibility?

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Illustration by Scott MacNeill

The Paradoxical PC

The IBM PC is a paradox. It has focused a lot of attention on 16-bit microprocessors, yet it's not a full 16-bit machine itself. (The Intel 8088 microprocessor the PC uses is a hybrid that has more in common with its 8-bit predecessor, the 8080, than its 16-bit sibling, the 8086.) The PC has triggered a flurry of software writing, but much of it is an attempt to catch up: translating programs that already exist on Apples and CP/M-based systems to run on the PC's operating system called (interchangeably) MS-DOS and PC-DOS.

The PC has probably been a major factor in escalating onboard memory to 256K bytes as a normal configuration for personal computers, yet until recently it was difficult to effectively put that much memory on the PC. Moreover, although IBM's original microcomputer is a nice-looking

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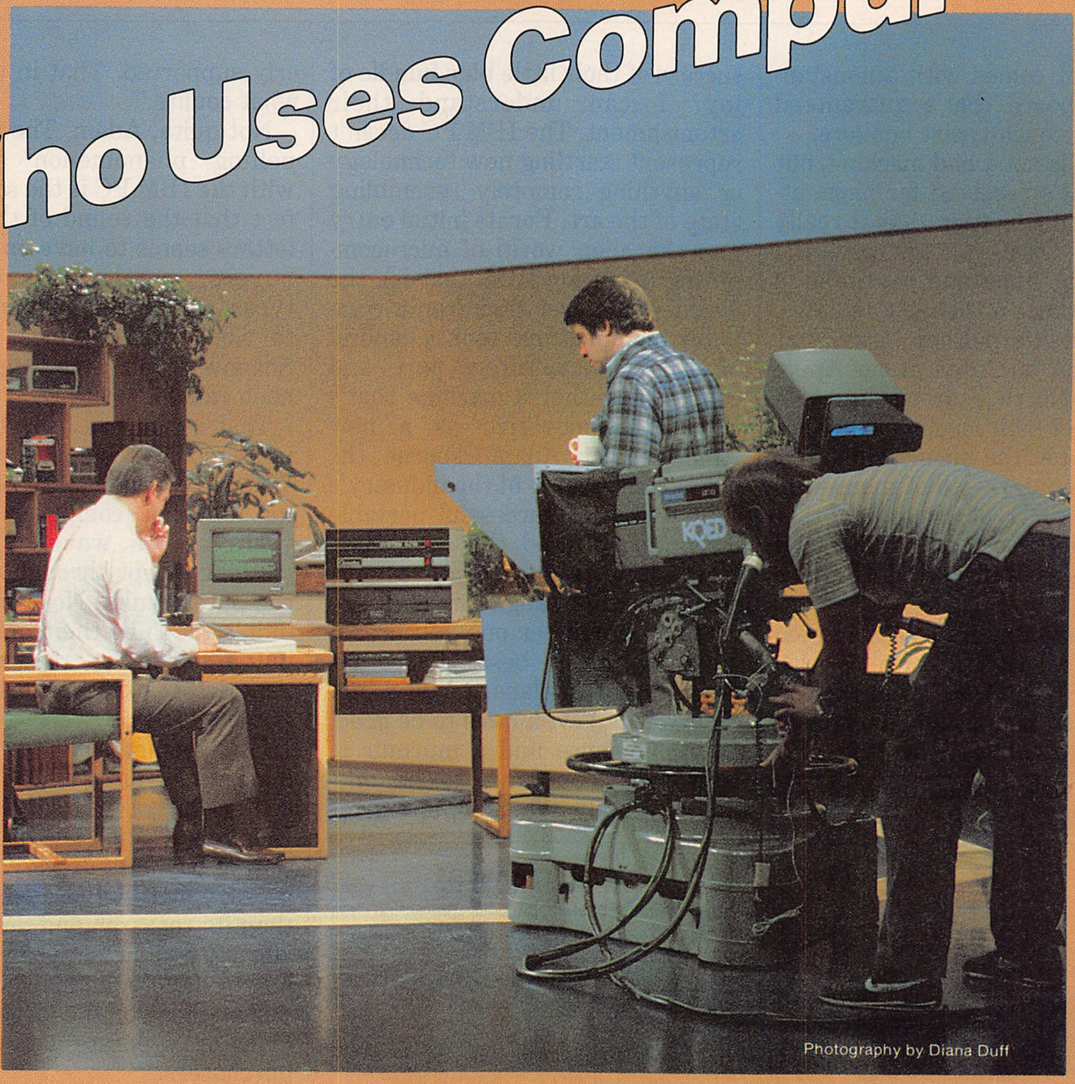
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machine, it comes with a nonstandard keyboard that's guaranteed to drive a touch-typist bonkers.

The PC is not a bad machine, but all in all it's received far more attention and adulation than it really deserves. Once you get past the advertising hype and the inflated and sometimes misleading reviews, you'll find it's neither better nor worse than an Altos or an Apple III or a North Star or any of a dozen other 8-bit machines that are all pointed at the business market. Those computers—all of them—will run the kinds of programs that most businesses need. And they'll run them as well as the IBM PC does.

I've heard rumors that some executives at IBM (which is also known as "Big Blue," after the color of its mainframe computer cases) were amazed at the early success of their little blue bundle of joy. I can understand their astonishment. The IBM PC doesn't represent startling new technology or anything remotely resembling state of the art. For its initial entry into the alien world of microcomputing (alien for IBM, that is), the world's foremost mainframe computer manufacturer took a handful of other manufacturers' parts and cobbled together a machine that's about as innovative as a new American car. Adam Osborne, the outspoken creator of the industry's first and most successful portable computer, offered this wry summary at a recent software symposium: "IBM taught us long ago that to be number one you do not have to be the best. (Pause for laughter and applause.) You do not (voice rising) even have to be *good.* (More applause and a murmur of approval.) You have to be adequate, readily available, and properly supported. That in the end is what counts."

Not quite, Adam. The most compelling phenomenon associated with the IBM PC is the soothing effect that the sound of those three letters seems to have on computer buyers, particularly corporate types, and an accompanying ability to cloud men's minds, a la The Shadow on old-time Sunday afternoon radio.

That sound has been less soothing for IBM's competitors, though. When IBM came on the scene with its personal computer just two years ago, a wave of fear and loathing swept through the microcomputer ranks. No wonder. IBM didn't get to be the dominant computer maker in the world—and America's sixth largest corporation—by being Mr. Nice Guy. IBM's reputation as a skilled marketing force and rapacious competitor is well deserved. Big Blue has affected an entire generation of business execs who are impressed more by IBM's sales force than its research and development labs. "You'll never lose your job by buying IBM equipment" is a credo still stamped on the foreheads of legions of corporate data-processing purchasers.

Why the Hysteria?

The IBM PC made waves even before it hit the stores, and those waves began to swell once it was on the shelves. It didn't seem to matter that the machine itself was technologically mediocre, that it initially had some bug-filled software, and that IBM's own salespeople didn't know how to operate it. It was an IBM— and in the minds of many buyers, IBM means COMPUTERS! A lot of corporations lined up to buy the PCs based on information so scanty and misleading it would have been insufficient to justify the purchase of hand towels for the executive washroom. In the final analysis, it didn't really matter how many bits the PC had or if it came with a foxtail aerial and a squirrel running in-

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A. Richard Immel is a contributing editor of *Popular Computing.*

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side. The fact that it had those three initials glued to the case was all that really mattered.

IBM's timing was impeccable. Microcomputers have long been pooh-poohed by the corporate mainframe crowds, those data-processing professionals who look down on Apples, TRS-80s, and the like as toys for hackers and game players. IBM introduced two new elements to all of this: first, a businesslike piece of equipment that looked like a three-piece suit; and second, confidence. "It doesn't matter *what* they did," explains one Fortune 500 office-systems manager. "Any way you look at it, it suddenly made risk assessment much different when you were considering an IBM PC." Indeed, why not buy the little ones from the people who sell you the big one? IBM would never let you down, would it?

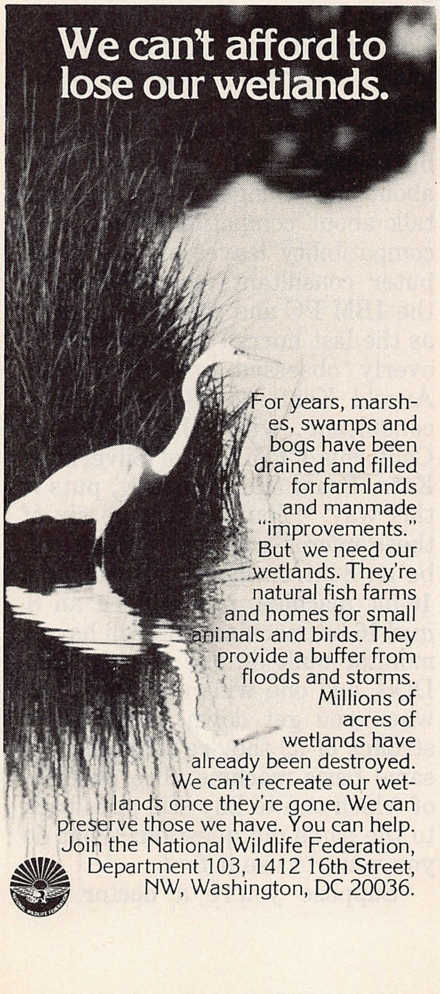
In the period it's been on the market, IBM's Personal Computer has become an immensely popular machine. Something like 200,000 machines were sold last year, the first full year of sales. That's not enough to bump Apple out of its number-one perch in the business market (25 percent), but it's enough to put IBM in second place with nearly 20 percent, ahead of Radio Shack's 15 percent.

Those Classy Coattails

Predictably, the PC has spawned a mini-industry of peripheral equipment: replacement disk drives, plug-in boards for added memory and better graphics, and other features IBM doesn't offer. In fact, all this activity resembles the cottage industry that sprang up around the Apple II (more than 300 firms are said to owe their existence to Apple), except in this case, the stakes are higher. The PC has also created a slew of IBM-compatible computers that use the same processor and resemble the IBM but have features it lacks, such as portability and lower price.

The IBM coattail brigade, with its various degrees of compatibility, is already more crowded than a Democratic primary. Adam Osborne, the dominant portable computer maker, recently jumped on the IBM bandwagon by adding IBM PC compatibility to his new Executive II. Even Texas Instruments, the nation's largest semiconductor manufacturer and a company known for its arrogance, swallowed its pride—and its chips—and earlier this year came out with an IBM look-alike business machine based on an 8088 microprocessor purchased from rival Intel Corporation.

A number of companies (among them, Osborne and Vector Graphic Inc.) have slapped 8088 processors onto their existing circuit boards,



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stuffed in additional memory, and are offering customers the best of both worlds: dual-processor computers (8-bit and 16-bit) and every operating system in the alphabet. Others, like Apple and Fortune, have totally ignored IBM and have instead proceeded to develop computers based on more advanced technology.

The various compatibles are shooting for different levels of compatibility. Ideally, they would all like to be similar enough to the PC so that the user could pop in an IBM floppy disk and run whatever programs are on it and also be able to talk to anything the IBM can talk to (such as an IBM mainframe). Some go even further: they are built to accept the same circuit boards that plug into the IBM.

There's a slight catch to all of this, however. Legally, you can never have 100 percent compatibility. Parts of the IBM architecture are patented, as are the circuit designs of most computers, and IBM's ROM (read-only memory), which contains important internal operating and utility information, is copyrighted. Other machines can approximate this ROM but not duplicate it. The ROM, then, is the rub for a would-be compatible machine because it's possible for programmers to develop software that depends on the unique internal design of the original machine.

Corporate buyers leaning toward IBM PCs are showing reluctance to buy IBM compatibles for two reasons: the price difference isn't that great (especially after IBM recently cut the price of the PC and added some memory upgrades), and buyers run the ever-present risk that IBM could throw a wrench into this compatibility by changing the ROM or making other proprietary enhancements. "They know how to play that game better than anybody else in the world," says one corporate exec. It's the way IBM has traditionally kept the rest of the herd in line, jerking the plug from its mainframe "plug-compatible" competitors when profit margins start slipping. One of the biggest bankruptcies in American business—Itel Corporation— was triggered by this kind of IBM muscle-flexing in the mainframe business.

Another IBM trick is to "cherry pick" peripheral enhancements to its machines. Independent manufacturers innovate their little hearts out, adding video boards, memory extensions, built-in hard disks, and all the bells and whistles that make the PC a more useful and efficient computer. When IBM spots something it likes, it comes out with its own "authorized IBM" version which, even at a higher price, tends to collapse the market for the independent. IBM already did this with its PC hard disk and memory upgrade, although in this case the ploy may backfire. Early users of the IBM 10-megabyte hard disk call it a "dog," and many corporate buyers are sticking with outside vendors.

Not Quite a Juggernaut

Does all this mean that IBM is destined to dominate the microcomputer market, just as it has dominated the mainframe market? Are we in store for some monolithic blue Pac-Man, gobbling up everything in sight? It's possible but not likely. IBM will be a factor for as long as it chooses to be, but bigness is not always a blessing. Huge companies aren't always as nimble as small ones and, after all, this is a new market for IBM. Selling $4000 microcomputers is wholly different from selling $4-million mainframes. One of the last year's major industry events was IBM's restructuring of its sales organization to eliminate embarrassing overlap. (Previously, salespeople from three separate IBM divisions had been calling on the same customers.) Some say the reorganization hasn't yet gelled.

IBM may have misjudged the market in another way. By coming in with a conservative, "safe" computer, it gave away a technological edge to the competition. For example, Apple's easy-to-learn, software-intensive Lisa is starting to turn the heads of even dyed-in-the-wool IBM "shops"—that is, companies that never before had seriously considered buying non-IBM equipment. IBM can probably match a Lisa, given time, but time is of the essence when you're going for market penetration in the high-technology business. Besides, more than one large company has found that bringing technology from the research and development labs to the marketplace is often easier said than done.

In any case, it's risk-assessment time right now in the corporate suites as office-systems buyers suddenly find themselves on the horns of a dilemma: Should they spend hundreds of thousands—or millions—of dollars investing in equipment that has a reassuring name on it but has a limited future? Or should they go with the next generation of technology—computers from Apple and Tandy and Corvus and Fortune that use the more advanced Motorola 68000 microprocessor?

Fortunately, owners of small businesses don't have to worry about such things. In fact, all this talk about compatibility and non-compatibility leaves a lot of computer consultants cold. They see the IBM PC and computers like it as the last hurrah for a generation overly obsessed with hardware. Arnold Kent, an 18-year veteran consultant with the Southern California CPA firm of Silverman, Katz, Fram and Company, puts it this way: "You can line up six of these micros and one of them will be an 8-bit machine, one will be a 16-bit machine, one will be an 8- *and* 16-bit machine, one will have a monitor built in, one will run MS-DOS, and one will run CP/M. But when you get down to the short strokes of it, they're all really the same basic machine. The problem of which one to buy still goes back to the same old question: What do you want to use it for?

"Suppose you're a doctor and

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Accounting Pack	$69.00	$32.00
Total 5.2 Word Processor—		
Plus	$69.00	$37.00
Disk	$79.95	$42.00
Total Text 2.6 Word Processor	$44.95	$26.00
Disk	$49.95	$26.00
Total Label 2.6	$24.95	$12.00
Disk	$29.95	$15.00
Quick Brown Fox Word Processor	$69.00	$40.00
Programmers Reference Guide	$20.05	$12.50
Programmers Helper	$69.00	$40.00
Basic Tutor	$29.95	$15.00
Typing Tutor	$29.95	$15.00
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Write or call for Sample SPECIAL SOFTWARE COUPON!

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This general ledger program is perfect for small business as well as home. It utilizes a double entry bookkeeping system. You only need enter one transaction and the computer will handle one transaction and the computer will handle the other. All accounts are user defineable and will bild for 1 year, resulting in a file of all transactions by account number, month and year to date. Each month a current months' trnsactions can be viewed at any time (99 accounts 187 entries per month). With this accounting program you will be able to monitor your financial growth as well as your expenses. List $59.00. Sale $49.00. Coupon Price $32.00. (tape or disk).

VIC-20 COMPUTER $77.00

You get the Commodore VIC-20 Computer for only $77.00 when you buy at sale prices: The Commodore Data Cassette for only $69.00 and the Gortek Introduction to Basic program for only $19.95. TOTAL LIST PRICE $302.95. SPECIAL PACKAGE SALE PRICE $165.25.

VIC-20 COMPUTER $88.00

When you buy 6 tape programs on sale for only $59.00. These 6 programs list for $100.00 to $132.00. You can choose one of three packs: 6 game pack, 6 home finance pack, or 6 small business pack. TOTAL LIST PRICE $360.00. SPECIAL PACKAGE SALE PRICE $147.00.

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System/drive model # ______________ Address ______________________

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some guy walks in your door with a good medical program written for the Sanyo computer. If the program does everything you want—if it can fill out California podiatrist forms and then send the forms to Blue Cross, let's say—then you'd be a moron to go out and buy anything but a Sanyo."

MS-DOS Plays Catch-Up

If software is the keystone, is it possible that all the good stuff is going to pile up on the PC or at least be written for the MS-DOS operating system? That seems unlikely. As I mentioned earlier, much of the activity in MS-DOS has been the transfer of existing programs—warhorses like Wordstar, Visicalc, and so on.

One thing that has surprised a lot of industry people is how quickly MS-DOS has stolen the show from the competing CP/M version for the PC (called CP/M-86). Overall, however, MS-DOS has a long way to go to catch up with the more common "8-bit" version of CP/M (that is, CP/M-80), and it lags behind programs written for the Apple as well. In fact, Sofsearch of California Inc., an Anaheim outfit that keeps track of which programs are available for which machines, showed this breakdown for business-oriented software packages (effective through the end of March 1983): CP/M-based micros—2506 packages available; Apple—1187; TRS-80—1103; and IBM PC—975. Those numbers don't reflect the quality of the programs, of course.

It's true that some of the newest integrated software packages like Context MBA and Lotus's 1-2-3 were created for the PC, but now they're available for other machines.

Obviously, IBM will continue to sell a lot of personal computers. However, for the small-business owner, as always, it boils down to individual choices for individual problems. The choice should always start with software and end with the nuts and bolts. The equipment you buy is far less important than what you can do with it. □

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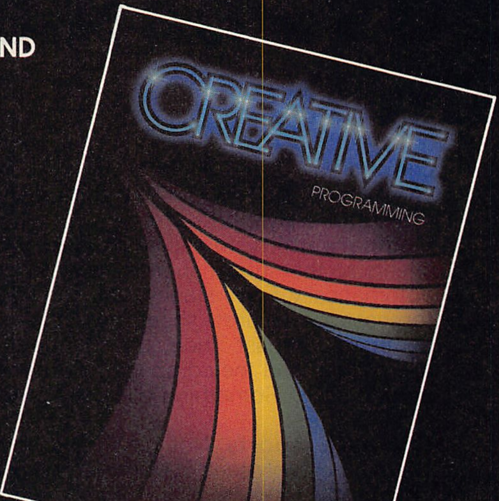

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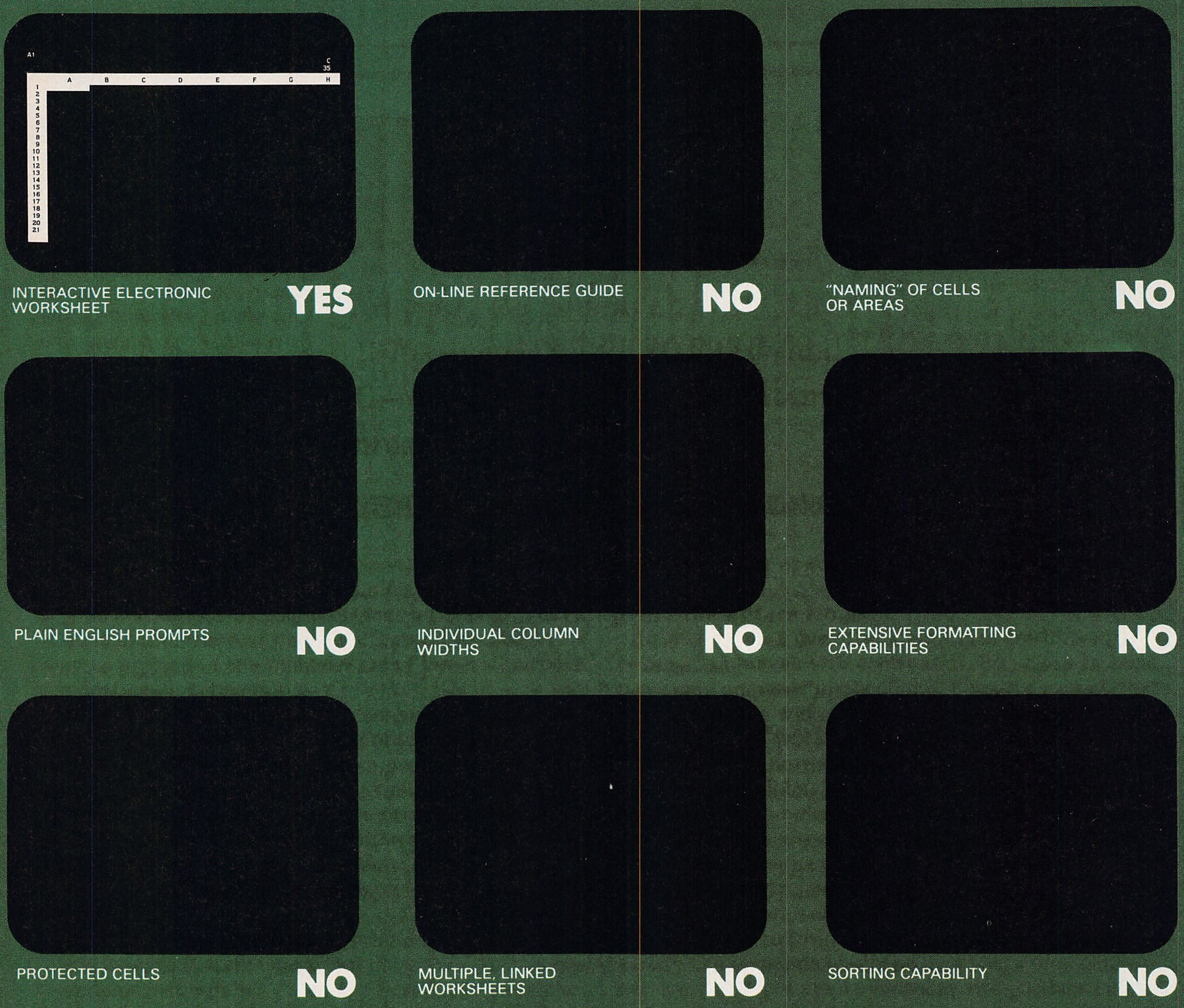
VISICALC*


A1
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35
A B C D E F G H
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
INTERACTIVE ELECTRONIC WORKSHEET YES
ON-LINE REFERENCE GUIDE NO
"NAMING" OF CELLS OR AREAS NO
PLAIN ENGLISH PROMPTS NO
INDIVIDUAL COLUMN WIDTHS NO
EXTENSIVE FORMATTING CAPABILITIES NO
PROTECTED CELLS NO
MULTIPLE, LINKED WORKSHEETS NO
SORTING CAPABILITY NO

VisiCalc® was a swell idea for then.

The next generation. First generation electronic worksheets were a good idea. They were early software management tools that could eliminate a lot of hours with a spreadsheet, calculator, pencil and eraser. Enter Multiplan, the next generation electronic worksheet that's as easy to use as it is useful.

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Compare ease of use. All Multiplan prompts are full length words or phrases. And Multiplan provides "naming," the ability to assign a plain English name to any cell or area. "Gross Profit = Sales—Cost" rather than "AA44=AZ23—BK154." Which means you can work more intuitively. And faster.

Compare utility. Multiplan lets you link related worksheets so that information is transferred between them automatically. For instance, you can keep regional sales forecasts on separate sheets but link them with your overall company forecast. Then, just change the forecast for any region, and the company forecast sheet is updated automatically. Something you can't do with first generation worksheets.

Compare reports. Not just the work you can do, but the way you can present it. Multiplan's flexible formatting options allow you to produce presentation-quality reports. And its sorting capability lets you sort by either alphabetic or numeric order. So a sales manager who normally lists sales regions alphabetically could sort by amount sold and conveniently rank by sales performance. The

*Based on features in releases VC-202B0-AP2 and VC-156Y0-IBM of VisiCalc on the Apple II and IBM-PC respectively.

MULTIPLAN

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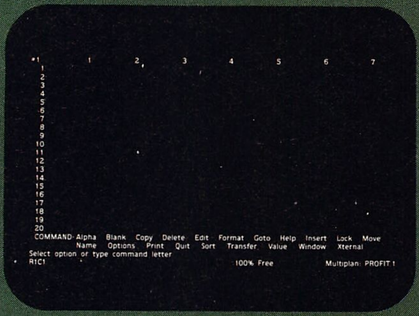

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#1        1        2        3        4        5        6        7
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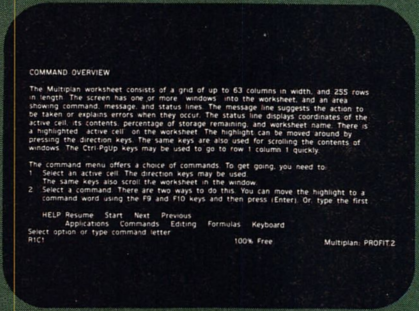
 20
 COMMAND: Alpha   Blank   Copy   Delete   Edit   Format   Goto   Help   Insert   Lock   Move
           Name   Options   Print   Quit   Sort   Transfer   Value   Window   Xternal
Select option or type command letter
R1C1                                      100% Free          Multiplan: PROFIT.1
```

INTERACTIVE ELECTRONIC WORKSHEET **YES**



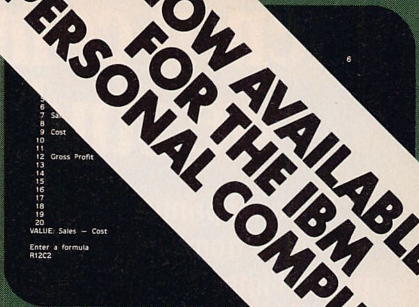
```
COMMAND OVERVIEW

The Multiplan worksheet consists of a grid of up to 63 columns in width, and 255 rows
in length. The screen has one or more  windows  into the worksheet, and an area
showing command, message, and status lines. The message line suggests the action to
be taken or explains errors when they occur. The status line displays coordinates of the
active cell, its contents, percentage of storage remaining, and worksheet name. There is
a highlighted  active cell  on the worksheet. The highlight can be moved around by
pressing the direction keys. The same keys are also used for scrolling the contents of
windows. The Ctrl-PgUp keys may be used to go to row 1 column 1 quickly.

The command menu offers a choice of commands. To get going, you need to:
1   Select an active cell. The direction keys may be used.
    The same keys also scroll the worksheet in the window.
2   Select a command. There are two ways to do this. You can move the highlight to a
    command word using the F9 and F10 keys and then press (Enter). Or, type the first

    HELP Resume   Start   Next   Previous
         Applications   Commands   Editing   Formulas   Keyboard
Select option or type command letter
R1C1                                      100% Free          Multiplan: PROFIT.2
```

ON-LINE REFERENCE GUIDE **YES**



```
                                                             6
  6
  7  Sa
  8
  9  Cost
 10
 11
 12  Gross Profit
 13
 14
 15
 16
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 18
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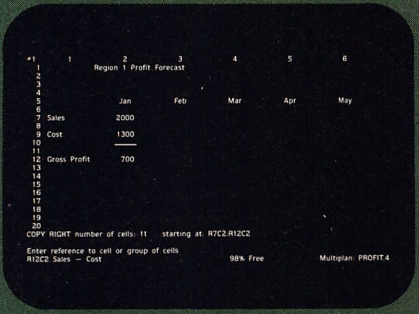
 20
VALUE: Sales - Cost

Enter a formula
R12C2
```

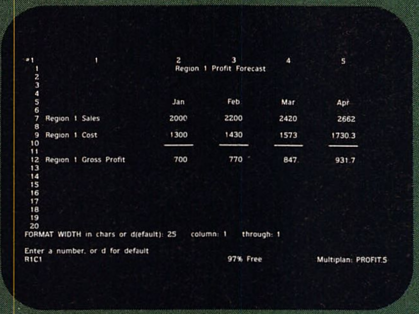
"NAMING" OF CELLS OR AREAS



```
#1        1            2          3          4          5          6
  1               Region 1 Profit Forecast
  2
  3
  4
  5                   Jan        Feb        Mar        Apr        May
  6
  7  Sales           2000
  8
  9  Cost            1300
 10                 ______
 11
 12  Gross Profit     700
 13
 14
 15
 16
 17
 18
 19
 20
COPY RIGHT number of cells: 11    starting at: R7C2:R12C2

Enter reference to cell or group of cells
R12C2 Sales - Cost                       98% Free          Multiplan: PROFIT.4
```

PLAIN ENGLISH PROMPTS **YES**



```
#1              1                  2          3          4          5
  1                          Region 1 Profit Forecast
  2
  3
  4
  5                               Jan        Feb        Mar        Apr
  6
  7  Region 1 Sales               2000       2200       2420       2662
  8
  9  Region 1 Cost                1300       1430       1573       1730.3
 10                              ______     ______     ______     ______
 11
 12  Region 1 Gross Profit         700        770        847        931.7
 13
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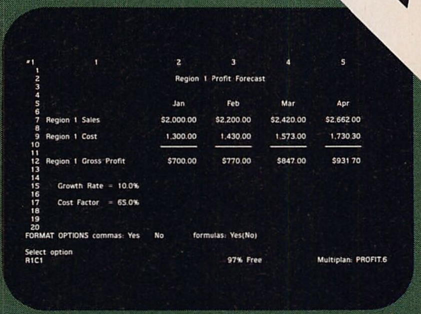
 18
 19
 20
FORMAT WIDTH in chars or d(efault): 25    column: 1    through: 1

Enter a number, or d for default
R1C1                                      97% Free          Multiplan: PROFIT.5
```

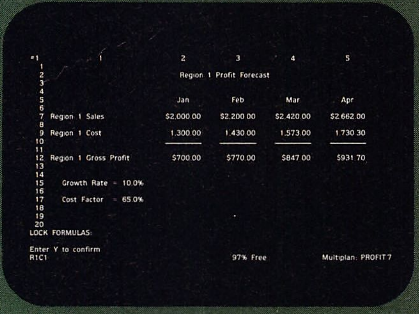
INDIVIDUAL COLUMN WIDTHS **YES**



```
#1              1                  2            3            4            5
  1
  2                           Region 1 Profit Forecast
  3
  4
  5                               Jan          Feb          Mar          Apr
  6
  7  Region 1 Sales            $2,000.00    $2,200.00    $2,420.00    $2,662.00
  8
  9  Region 1 Cost              1,300.00     1,430.00     1,573.00     1,730.30
 10                            __________   __________   __________   __________
 11
 12  Region 1 Gross Profit       $700.00      $770.00      $847.00      $931.70
 13
 14
 15     Growth Rate  =  10.0%
 16
 17     Cost Factor  =  65.0%
 18
 19
 20
FORMAT OPTIONS commas: Yes   No        formulas: Yes(No)

Select option
R1C1                                      97% Free          Multiplan: PROFIT.6
```

EXTENSIVE FORMATTING CAPABILITIES **YES**



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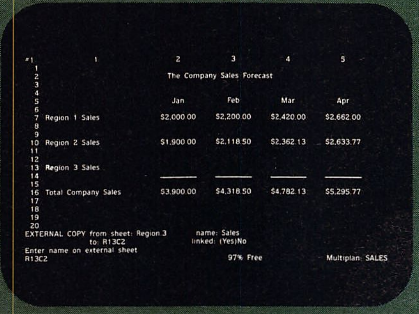
#1              1                  2            3            4            5
  1
  2                           Region 1 Profit Forecast
  3
  4
  5                               Jan          Feb          Mar          Apr
  6
  7  Region 1 Sales            $2,000.00    $2,200.00    $2,420.00    $2,662.00
  8
  9  Region 1 Cost              1,300.00     1,430.00     1,573.00     1,730.30
 10                            __________   __________   __________   __________
 11
 12  Region 1 Gross Profit       $700.00      $770.00      $847.00      $931.70
 13
 14
 15     Growth Rate  =  10.0%
 16
 17     Cost Factor  =  65.0%
 18
 19
 20
LOCK FORMULAS:

Enter Y to confirm
R1C1                                      97% Free          Multiplan: PROFIT.7
```

PROTECTED CELLS **YES**



```
#1              1                  2            3            4            5
  1
  2                          The Company Sales Forecast
  3
  4
  5                               Jan          Feb          Mar          Apr
  6
  7  Region 1 Sales            $2,000.00    $2,200.00    $2,420.00    $2,662.00
  8
  9
 10  Region 2 Sales            $1,900.00    $2,118.50    $2,362.13    $2,633.77
 11
 12
 13  Region 3 Sales
 14                            __________   __________   __________   __________
 15
 16  Total Company Sales       $3,900.00    $4,318.50    $4,782.13    $5,295.77
 17
 18
 19
 20
EXTERNAL COPY from sheet: Region.3        name: Sales
                   to: R13C2             linked: (Yes)No
Enter name on external sheet
R13C2                                     97% Free          Multiplan: SALES
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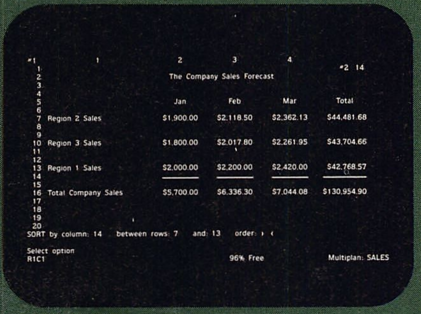
MULTIPLE, LINKED WORKSHEETS **YES**



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#1              1                  2            3            4
  1                                                                   #2  14
  2                          The Company Sales Forecast
  3
  4
  5                               Jan          Feb          Mar          Total
  6
  7  Region 2 Sales            $1,900.00    $2,118.50    $2,362.13    $44,481.68
  8
  9
 10  Region 3 Sales            $1,800.00    $2,017.80    $2,261.95    $43,704.66
 11
 12
 13  Region 1 Sales            $2,000.00    $2,200.00    $2,420.00    $42,768.57
 14                            __________   __________   __________   ___________
 15
 16  Total Company Sales       $5,700.00    $6,336.30    $7,044.08    $130,954.90
 17
 18
 19
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SORT by column: 14    between rows: 7    and: 13    order: › ‹

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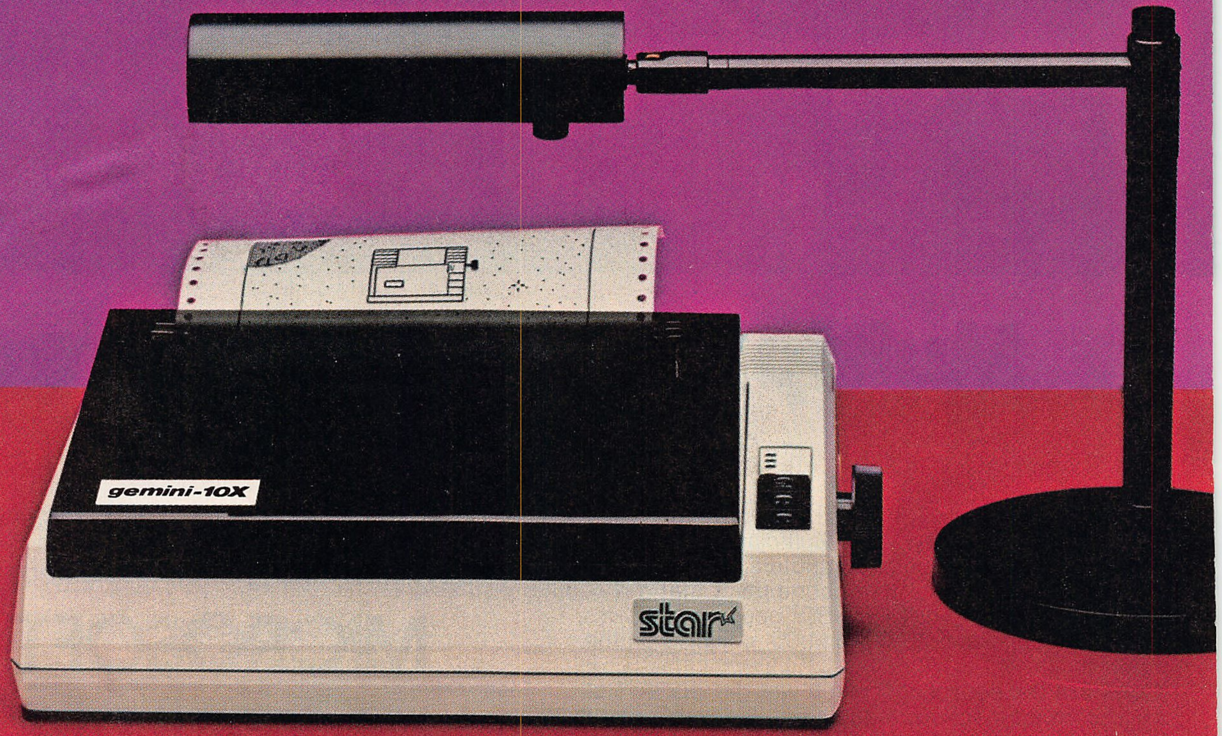


Printing Like the Pros

Some tips that can turn your printer's output into an attractive publication

by William Barden Jr.

Many people buy computer systems with the express purpose of producing their own newsletters and magazines. But unless you know some basic facts about production and layout, these computer-generated projects wind up looking like "fanzines"—those sloppy newsletters that fans send each other (whether they're fans of Engelbert Humperdinck or the latest "Compaticomp" computer). In short, the words stored on floppy disks and output on your nifty printer won't get the desired reader response if you botch the production phase.

It all boils down to this: if you spend several thousand dollars on a computer system, why settle for self-published brochures, newsletters, and magazines that look *worse* than manuscripts produced on a pre-World War I manual typewriter? Heeding the tips that follow may not qualify you as a production manager for *Vanity Fair*, but they are sure to help you produce publications that look very professional.

Theoretically, you could use your printer to make hundreds of hard-copy originals, hence avoiding the cost of offset printing altogether. But as every printer owner knows, some hard copies come out better than others. Therefore, we'll assume that you'll use your computer's printer to make an eye-fetching original—camera-ready copy—that you'll eventually take to a print shop for duplication by the hundreds.

If you've never had anything printed before, here are some basic guidelines. Typical printing costs at a print shop run about $5 per 100 sheets of high-quality bond paper, in either white or pastel colors. In photo offset printing, a photograph is made of your original and the negative is then used to make a printing plate used in the actual printing. Photo offset is one-color printing, usually black (although different color inks can be used).

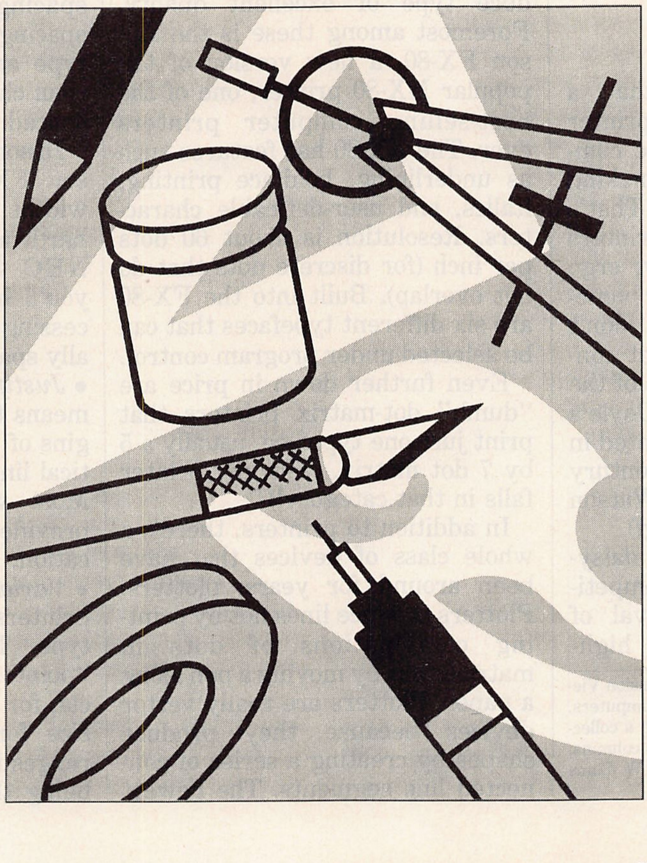
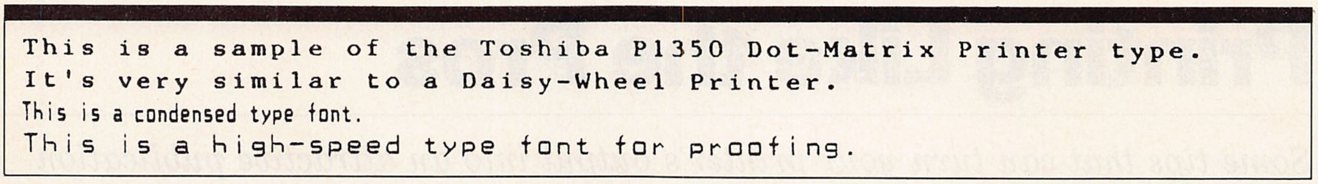


Illustration by Anders Wenngren

The photo offset process can be used for everything from one-page advertising flyers to full-length books. The more copies made from each plate, the less it costs per single copy. Printing 100 copies of a 5½- by 8½-inch, 32-page newsletter, stapled in the middle, costs about $.70 per newsletter. Printing 5000 copies of a 150-page book with the same dimensions runs about $1.50 per book or about 1 cent per page including printing and binding. (These estimates are for a printer specializing in books.)

Printers are more than happy to work with you on all kinds of projects. Most print shops have equipment for printing, cutting, and binding. All you have to do is bring in the camera-ready copy. These camera-ready pages, called "mechan-



This is a sample of the Toshiba P1350 Dot-Matrix Printer type.
It's very similar to a Daisy-Wheel Printer.
This is a condensed type font.
This is a high-speed type font for proofing.

High-resolution dot-matrix printers and plotters can produce text similar to that produced by daisy-wheel printers.

icals" in publishing jargon, consist of the material to be printed (mounted on a cardboard sheet) ready to be shot by the camera that will produce the negative. Mechanicals aren't strictly necessary in the case of smaller publications; simply use a large sheet of paper.

The most important factor in preparing the camera-ready copy is to provide printed material that has good contrast. In many cases this material is typeset (produced on a typesetting system), but it can just as well be hard copy you output with your own printer. Black ink will "burn into" the negative used to make the printing plate. Anything else—strips of paper that you've pasted up, editing marks made with a nonreproducible-blue pencil, Liquid Paper corrections, and the like—won't show up on the negative.

Daisy-Wheel Still Champ

There's no disputing that a letter-quality daisy-wheel printer is the best device the home computerist can acquire for making camera-ready hard copy. That's because most daisy-wheel printers let you change fonts easily; ergo you can vary the look of your homebrew publication. (If you don't think fonts are an important consideration, try reading some of the reproductions of Conan Doyle's Sherlock Holmes stories printed in *Strand* magazine about a century ago. It's a miracle that Dr. Watson didn't need a seeing-eye dog!)

As a master-maker, the daisy-wheel printer had little competition until the recent arrival of machines like Toshiba's high-resolution dot-matrix printer. That company's model P1350 can print about 180 dots per inch. This new printer produces hard copy that compares favorably to copy created by many daisy-wheel or NEC Spinwriter-type printers (see figure above), and indications are that several manufacturers are pursuing even finer resolution.

The Toshiba printer has the advantage of "dynamic" font changes. You program new fonts by entering keyboard commands that select predetermined read-only-memory patterns; no type wheels have to be changed. In addition, you can create custom patterns by outputting in a graphics mode.

At a lower price—and with lower resolution—you can find quite a few dot-matrix printers that produce type of excellent quality. Foremost among these is the Epson FX-80, a new version of the popular MX-80 printer, one of the best-selling computer printers ever. The FX-80 has features such as underlining, boldface printing, italics, and user-definable characters. Resolution is about 60 dots per inch (for discrete dots that do not overlap). Built into the FX-80 are six different typefaces that can be selected under program control.

Even further down in price are "dumb" dot-matrix printers that print just one typeface, usually a 5 by 7 dot matrix. (Yes, my printer falls in that category!)

In addition to printers, there's a whole class of devices that have been around for years: plotters. Plotters produce lines not by printing combinations of dots in matrices but by moving a pen along a paper. Plotters are really vector devices because they produce shapes by creating a series of connected line segments. The newest plotters are inexpensive and have a great deal of intelligence built in. They can plot characters of almost any size or shape, along with ruled lines.

Features to Look For

Hand in hand with a printer or plotter, you'll need a word-processing program to produce text for printing. Here are some features you can get from a word-processing program or printer that make for high-quality printing:

- *Proportional spacing.* If you look at the type in newspapers, magazines, or books, you'll see that an "i" is allocated less horizontal space than an "M." This kind of spacing, known as proportional spacing, makes for more pleasing type and is much easier to read than characters that are uniformly spaced.

In some printers (such as the Epson FX-80) a table of character widths is built into the printer hardware. With other printers (the NEC Spinwriter for example) you'll have to use your word-processing program to get proportionally spaced text.

- *Justification.* This term simply means that the left and right margins of the copy form straight vertical lines instead of being ragged. Most word-processing programs provide at least left-margin justification.
- *Variable-size type.* Some newer printers let you vary the size of the type. Type size is measured in "points." The type size in this article, for example, is 10 point. Type size for most computer printers ranges from 8 to 12 points, with 12 being the most common. Varying

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Columnist William Barden Jr. lives in Mission Viejo, California, and writes about small computers. *What Do You Do After You Plug It In?*, a collection of the author's *Popular Computing* columns, is scheduled for publication by Howard W. Sams and Company Inc.

the type size is handy for headings.

- *Variable leading.* Uh-oh, another typesetting buzzword. "Leading" (rhymes with sledding) simply refers to the spacing between lines of type. The term derives from the lead slugs used to space lines of type back in the days of "hot" type. On most printers, line spacing is 6 lines per inch, or "12-point lead" (there are 72 points per inch). On newer printers you can increase the line spacing to 8 or 10 lines per inch. On printers such as the Toshiba or NEC Spinwriter, you can vary the leading in increments of 1/120 inch. Again, fancy leading is used primarily for aesthetic purposes.
- *Special symbols.* Sometimes special symbols are defined in the printer's hardware; other times you can define symbols by a dot-matrix coding and then download them to the printer, as in the case of the FX-80. Many of the newer printers have a block-graphics character set that enables you to print shapes and line segments and draw continuous rules (straight lines) vertically or horizontally by connecting line segments.

Creating Camera-Ready Copy

Although it's hard to generalize about how to prepare copy for a brochure, newsletter, or book, here's a sample walk-through:

Using your word-processing program, print a rough draft of the text. Carefully proofread this copy for grammar, spelling, and punctuation. A style guide (see the reference for Strunk and White's *The Elements of Style* in the box at right) can help you organize and clarify your writing.

Make the necessary revisions and print a second draft. Continue this process until you don't find any errors. At that point, put the text aside for a while and then proof it *again*: errors and typos are as pervasive as program bugs.

Once you've finished checking the rough copy, you're ready to do the page layout. You usually need to make what's called a "dummy"—a model of the page you're creating—with relative locations of headlines, figures, captions, and so on. The dummy will vary, of course, from straight text on a page to elaborate layouts filled with drawings and text. You can use black-and-white photos, but you should talk to your printer about them first. In some cases, photos are "stripped into" the negative before printing. In other cases, screened photos can be pasted up directly on the master copy. The latter method produces photos of a quality adequate for newsletters and even some books.

Don't forget when doing the page layout that you can make the master oversized. If the final page is to measure 5½ by 8½ inches, you can make the master any multiple of those dimensions, say, 6.875 by 10.625 inches. The master is then "shot down" or "reduced" to 80 percent of its original size. Reducing artwork and text in this manner lets you squeeze more material on a page and bolsters the visual appeal of otherwise drab layouts. (Naturally, it's less expensive to forget about reductions and stick to 8½- by 11-inch pages.)

To fit more material on a page, try printing columns that are 1½ to 2 inches wide instead of the usual 6 or 7 inches wide. Most word processors let you easily change the column width.

When making your original hard copy, always use a new or re-inked ribbon (ribbon re-inkers are available for many printers for $40 or so). Use a carbon ribbon for daisy-wheel printers or Spinwriters, and take advantage of the double-strike feature (found on printers such as the Epson MX-80 or FX-80) to get clear, dark copy.

Use rubber cement to paste up the output from your printer. Rubber cement is easily removed, will not soak through paper and stain printed matter, and lets you easily shift around the pieces of paper that you've pasted up on the master. (An alternative to rubber cement is waxing, where you apply a special wax to the back of paper. You can then lay the waxed piece down for positioning and remove it easily if you need to reposition it. Waxers are available for a modest price from printers' supply houses.)

Don't hesitate to cut and paste at

Resources to Help You Self-Publish

Tex and Metafont: New Directions in Typesetting, by Donald E. Knuth (Digital Press, 1979) describes the Tex system, a system for setting technical text.

The Design of Books, by Adrian Wilson (Peregrine Smith Inc., 1974) discusses book design, stressing aesthetics.

The Printer's Shopper (PO Drawer 1056, Chula Vista, CA 92012) is a mail-order catalog of printers' equipment, paste-up materials, and publications.

The Elements of Style, 3rd ed., by William Strunk and E. B. White (Macmillan Co., 1978) is the famous "little book" of basic style.

Editing Your Own Newsletter: A Guide to Writing, Design, and Production, by Mark Beach (Coast to Coast Books, 2934 North East 16th Ave., Portland, OR 97212, 1980) has everything you need to know about newsletter production (except for the computer and word-processing portion).

A Complete Guide to Pasteup, by Walter B. Graham (Dot Pasteup Supply Co., POB 369, Omaha, NE 68101, 1980) tells you more than just how to paste up.

Publishing Short-Run Books, 2nd ed., by Dan Poynter (Para Publishing, POB 4232, Santa Barbara, CA 93103, 1981) outlines production of small books.

will. If you don't have time to make corrections by reprinting and pasting over old material, use correction fluid instead. As long as the corrections don't sharply contrast with their surroundings, you'll never see them once the master negative is made.

When you've finished the final master, check one last time for misspellings, grammar, and punctuation. Also white out any dark spots on the pages. The master is now ready to go to the printer. He'll shoot the material and then give you back the pages, stapled newsletter, or bound book. In the case of larger books, you'll also get a chance to see the "bluelines," a preliminary copy made from the photographic negative before the actual print run.

Working with a Typesetter

Although originals made on a computer printer can look very nice, especially when proportionally spaced, justified, and output on a letter-quality printer in a pleasing font, the ultimate yardstick for printed text is copy from a typesetting system. A typesetter is not what you might visualize—a crusty old coot setting slugs of lead type on a Linotype machine. Most typesetting is now done on minicomputers in tandem with phototypesetting machines, systems that are super fast, quiet, and versatile.

What you should avoid is having a typesetting firm set your type by manual entry. It's much too expensive to have an operator look at your printed copy and type it into a computer system *again* prior to getting typeset copy. Virtually all typesetters have an RS-232C interface which enables them to receive data from a modem connected to a phone line. At the other end of the phone line, of course, are your modem and RS-232C interface feeding text from a disk file created by your word-processing software. The typeset copy is mailed to you after processing.

Typesetters use commands that control the typefaces, size of type, justification, leading, and much more. The chief problem when you work with typesetters is to know what these codes are and to embed them at the right places in your text. There are basically two ways to solve this problem: send your text to the typesetters via your modem and let *them* put in codes at the proper places or take a crack at embedding the codes yourself. The first method is more expensive than the second, as the typesetter will have to spend a good deal of time working with you to get the correct formats. I favor the second method. The commands aren't *that* difficult to master; you'll find that many of them are similar to those used in word-processing programs.

You might want to write to a firm called Intergraphics Inc. (106-A South Columbus St., Alexandria, VA 22314), to get a 124-page booklet called *A Guide to Personal Publishing*. It describes the firm's system for dial-up typesetting via modems. More than that, though, the booklet provides an excellent overview of typesetting, design, and paste-up.

Oh, yes, the cost of computerized typesetting with embedded commands? As of this writing, Intergraphics charges $2 per 1000 characters, making the cost about 1 cent per word. Many other type houses will work with you either modem-to-modem or directly from your word-processing disk files.

I'm very optimistic about the future of computerized self-publishing. Soon we'll see low-cost, extremely high-resolution dot-matrix printers—not to mention ink-jet printers—that can produce high-quality type in a variety of styles and sizes. That's good news for you fledgling Hemingways and Updikes who are wary of vanity presses and publishing conglomerates. □

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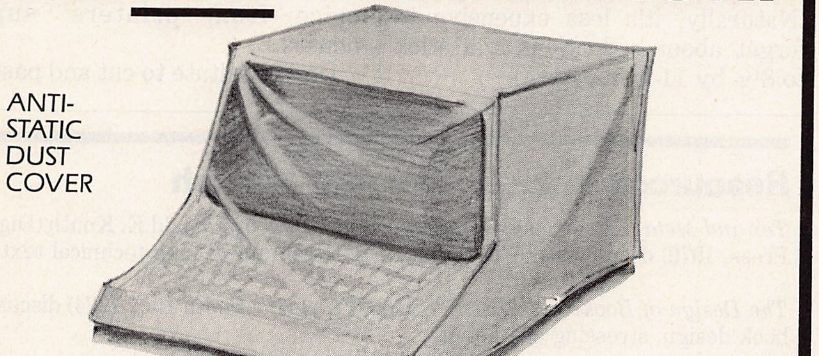

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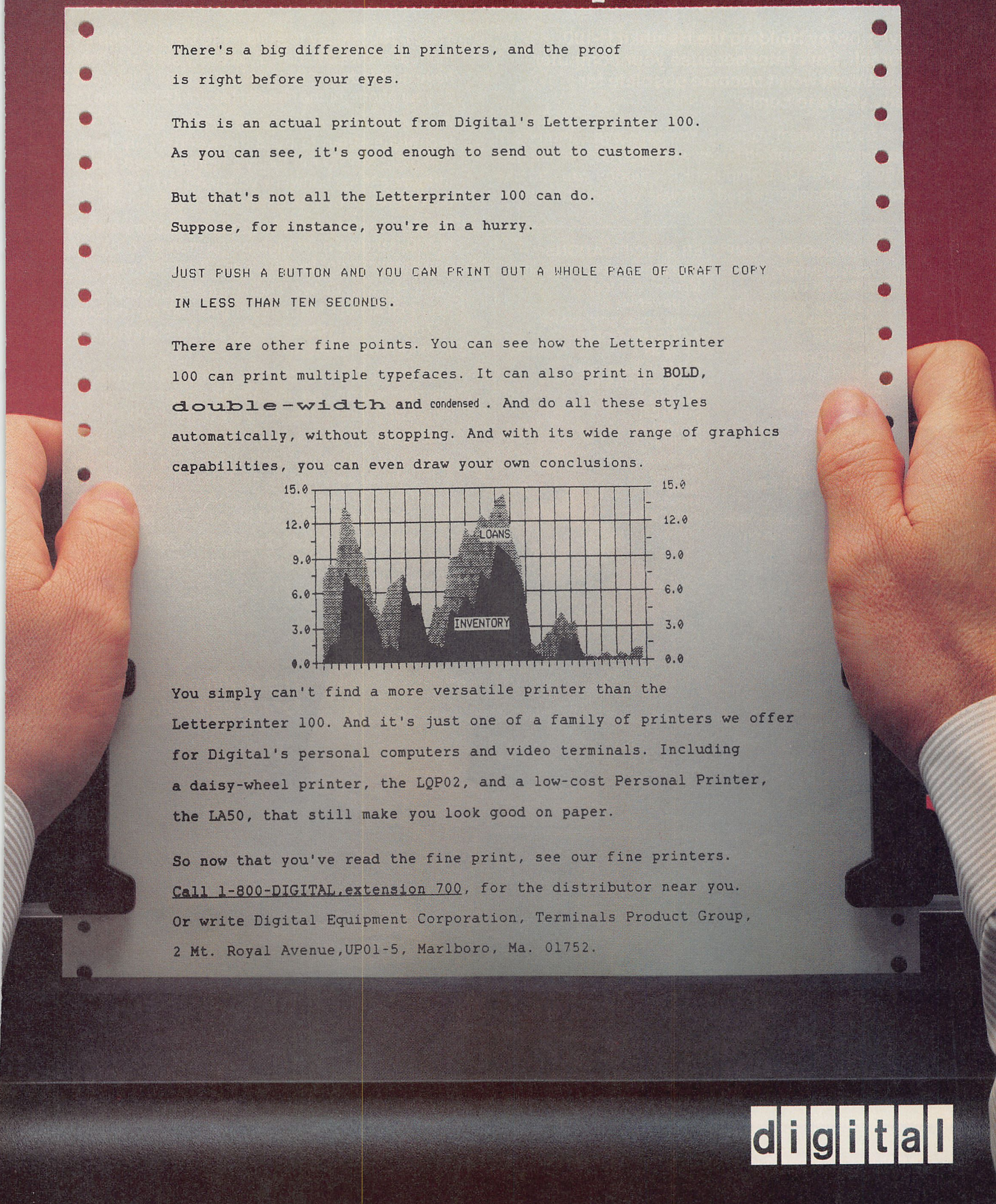

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The Push for Standardization

Are we ready for an advanced placement test in computer science?

by Dan Watt

Give me a lever and a place to stand," Archimedes is supposed to have said, "and I'll move the world." This year a group of computer science educators—with the blessings of the powerful College Entrance Examination Board and the Educational Testing Service (ETS)—has chosen an advanced placement test for high school students as a lever and the computer language Pascal as a place to stand in an attempt to move the educational world toward a more coherent approach to teaching computer science.

Computer education seems to be ready for standardization. During the past few years, low-cost microcomputers have changed the nature of computing in schools as rapidly as they've changed the rest of the world. From a minor elective of interest to only a few students with unusual mathematical proclivities, computing has become part of the educational mainstream. And because this transformation has happened virtually overnight, educators have had no time to forge a consensus about what should be taught, when, and to whom.

Indeed, the few curriculum standards that do exist have not received universal support from educators. The choice of BASIC as the standard language for teaching programming, for example, was made by computer manufacturers, not by educators. Because BASIC is built into almost every microcomputer, the decision to use BASIC to teach programming was a foregone conclusion. And in the past year, we've seen a surge of interest in Logo, heavily promoted by some computer companies, as a programming language for elementary school students. Once again, manufacturers are showing the way, not educators.

The Advanced Placement Test

A select group of educators wants to change that trend. In May 1984, high school seniors will get their first crack at an advanced placement (AP) test in computer science. AP tests are given to high school students who have completed the equivalent of a first-year college course in a particular subject. These tests serve the needs of an elite group of students, motivating them to accelerate and deepen their learning. Students who pass AP tests may earn college credit or be excused from taking the corresponding courses in the first year of college. The number of students who take AP tests varies with the subject. The most popular tests are in English literature and composition with 51,000 takers, followed by calculus. The least popular AP test is in music; only about 600 high school students took that

Illustration by Jean Tuttle

examination last year.

The development of a typical AP test is relatively straightforward because introductory college courses in most subjects are fairly standardized. In computer science, however, the situation is a lot less clear. First of all, the field is so new that even at the college level there are widespread differences in the ways it is taught. In fact, according to Phillip Miller, a senior lecturer in computer science at Carnegie-Mellon University and a member of the committee that is developing the AP test, many people who teach computer science in colleges were not originally trained in the field themselves. Second, because the AP test is the first national test in computer science, it has to be created from scratch and cannot be based on earlier ways of evaluating the subject.

According to James Braswell, an ETS consultant, the AP test represents a kind of consensus among high school and college teachers. "First the College Board appointed a committee consisting of high school computing teachers and college professors of computer science," explains Braswell. "Then the committee sat down and developed a course outline and philosophy and circulated it widely for reaction among approximately 500 high school teachers and 200 college faculty members." After circulating the course outline and getting the teachers' reactions, the committee made some minor changes and sent a full-scale course description with sample test questions to schools and colleges.

The Pascal Connection

The goals of the course are that a student learn to "design and implement computer-based solutions to problems in several application areas" and that in order to do so, the student learn to identify and select appropriate algorithms and data structures and to "program fluently in a well-structured fashion." Furthermore, a student should have some knowledge of computer systems and an awareness of the social and ethical implications of computer use, although these latter subjects are not spelled out in much detail in the course outline.

The first major decision faced by the course developers was the choice of a programming language. The need to foster a structured approach to programming led directly to Pascal. "While good programmers can write such programs in almost any programming language, certain languages encourage good programming habits more than other languages," says the committee in its course description. "The language [used in this course] must facilitate structured programming and a high degree of modularity." Concerned about what might happen if some schools tried to teach the course using a language that is less than adequate, the committee decided to require the use of Pascal, which is already gaining widespread acceptance in colleges.

Testing Conflicts

Even if students do learn to program well, it's difficult to test what they know. Arthur Luehrmann, author of programming texts in both Pascal and BASIC, likes to compare computer programming with writing. "The easiest thing to test in English is the mechanics—spelling, grammar, and punctuation," says Luehrmann. "The hardest thing to test is whether a kid can write. Can he put ideas together into a coherent whole that makes sense? That's almost impossible to determine through standardized testing. Computing is like that too. The easiest thing to test is whether someone knows a computer language, that is, the vocabulary, spelling rules, and syntax. The hardest thing to test is whether, given a problem stated in English, the kid can solve the problem with a coherent computer program."

Designers of the AP test are aware of this problem and have based their solution on what has been done for years in the AP English test. The 3-hour computer exam will include two parts, each of which will receive equal weight. The first part will be a long series of multiple-choice questions; the second will consist of open-ended questions "requiring the students to demonstrate their ability to design, write, and document programs and procedures." The second half will be graded "not only on the correctness of that program or procedure but also on its design, style, and documentation."

This method of testing, however, could create a serious conflict between what the course developers intend to achieve and what students and teachers actually do. As students prepare for the test, they'll be sure to concentrate on creating acceptable solutions to the type of short programming problems included in the test booklet. Thus, the test may force students to practice a relatively narrow form of programming, rather than encouraging them to develop the broad skills that the course is attempting to promote.

How many students will take the AP test in computer science? Carl Haag, who directs all of ETS's AP programs, estimates conservatively that between one and two thousand students may take the test in May 1984. James Braswell of ETS believes that the number could reach three or four thousand next year. Committee member Phillip Miller of Carnegie-Mellon is the most optimistic, suggesting that as many as 10,000 to 12,000 students could take the test next spring and that the total could soon rival the numbers for the English test with about 50,000 takers each year.

The Test's Influence

Because the AP test will be the first nationally administered test in computer science or programming below the level of graduate school, its influence may extend far

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Dan Watt is a contributing editor of *Popular Computing* and the author of *Learning with Logo* (BYTE Books/McGraw-Hill, 1983).

beyond the number of students who actually take it every year. "In developing the test we felt it incumbent to lead, rather than just follow what was already happening," says Miller.

"We hope colleges will support the educational goals we've established. Personally, I'll be very disappointed if that doesn't take place. The course has already influenced what's being taught at the high school level. I think it will have ramifications on down to the middle school as well," adds Miller.

Adamantly opposed to the course is Harold Abelson, a professor at the Massachusetts Institute of Technology who teaches introductory computer science to 30 percent of the school's undergraduates. He disagrees with the focus and says that the use of Pascal is a "disaster." "Many of the most important ideas in computer science are not easily expressed in Pascal," Abelson explains. "You can't write a procedure that generates other procedures, for example. There shouldn't be any real distinction between what you think of as procedures and what you think of as data. And this idea turns out to be the key to a lot of extremely important techniques of computer science that we cover in our introductory course. Pascal is good as a low-level implementation language where you want to have very strict control over what goes into every memory location in the computer. It's not good as a high-level language."

For an introductory course, says Abelson, it's critical that a language be interactive. "In Pascal, programming involves writing a 30-page hunk of code and then compiling it to see if it runs. Pascal is extremely weak on debugging facilities." Abelson also believes that the AP course places too much emphasis on "computer science" and not enough on what the computer is being used for. "I think people should use computers as tools for studying subjects like mathematics and science. What concerns me is that with so much energy going into programming and coding and data structures and stuff like that, not enough energy is going into important things like teaching calculus better."

Do We Want Standardization?

Just a few years ago it was unusual for high school students to take even one course in computer programming—they were lucky if they had a few weeks of introductory BASIC sandwiched between topics of a math course. Most students had to wait until college to do their first real programming. Now entire courses in BASIC are common in high schools, and introductory programming is being taught in many elementary schools.

Given the rate at which computer education is changing and the diversity of opportunities offered at different schools and in different communities, it seems inevitable and justifiable to push for standardization. But is this really the time for it? With changes happening so fast, do we want to freeze things as they are today?

The AP test committee and its backers are convinced the time is right and the introductory computer science course they define today will be valid for years to come. Others are less certain. Arthur Luehrmann is a cautious advocate of standardization, but he thinks a number of factors must be taken into account, and he worries that the AP committee may not be representative enough to set standards for everyone.

"It's essential that we reach some agreement on what the curriculum in computer science and computing should consist of. But the process should involve a combination of knowing what teachers are able to teach, what materials publishers choose to provide, and what the testing agencies decide to test.

"Testing has been one of the most conservative forces in education. Tests usually come in after the fact and set standards that are extremely difficult to dislodge. In this case, the test is coming before the fact and may be setting an irrational standard if it's used for anyone other than an elite group of students," Luehrmann asserts.

Sandy Wagner, a founder of California's Computer-Using Educators (CUE), actively opposes giving the test. As coordinator of computer education for Santa Clara County in the heart of Silicon Valley, he feels it's too soon to be setting standards of any kind. In addition to the AP test, he's worried about a California proposal to make a one-semester computer-literacy course a requirement for high school graduation. "As soon as you write down the specifics, the textbooks will start reflecting it, and everyone will adopt it as the only course of study. I don't think we're ready for that. We don't know enough yet to put things in stone. We need time to let many flowers bloom and develop new models."

The current drive for standards is natural, even inevitable, given the confusion that comes with change. But I can't help feeling uncomfortable with the idea of setting standards for such a new field. I do think it's good that schools offer courses in Pascal. To the extent that the AP course helps eliminate the idea that BASIC is the best language for teaching programming, I see the course as positive—as long as it doesn't impose another premature standard in place of BASIC. Students should be able to take courses in Pascal, BASIC, and Logo.

But schools need to be flexible enough to adapt to new approaches to computer science that might be possible with even more powerful programming languages a few years from now. Standards that take just a few years to establish could take decades to change. The 1980s will be a time of transition in computer education. We can't afford to be locked into a current standard when the situation is changing so fast. □

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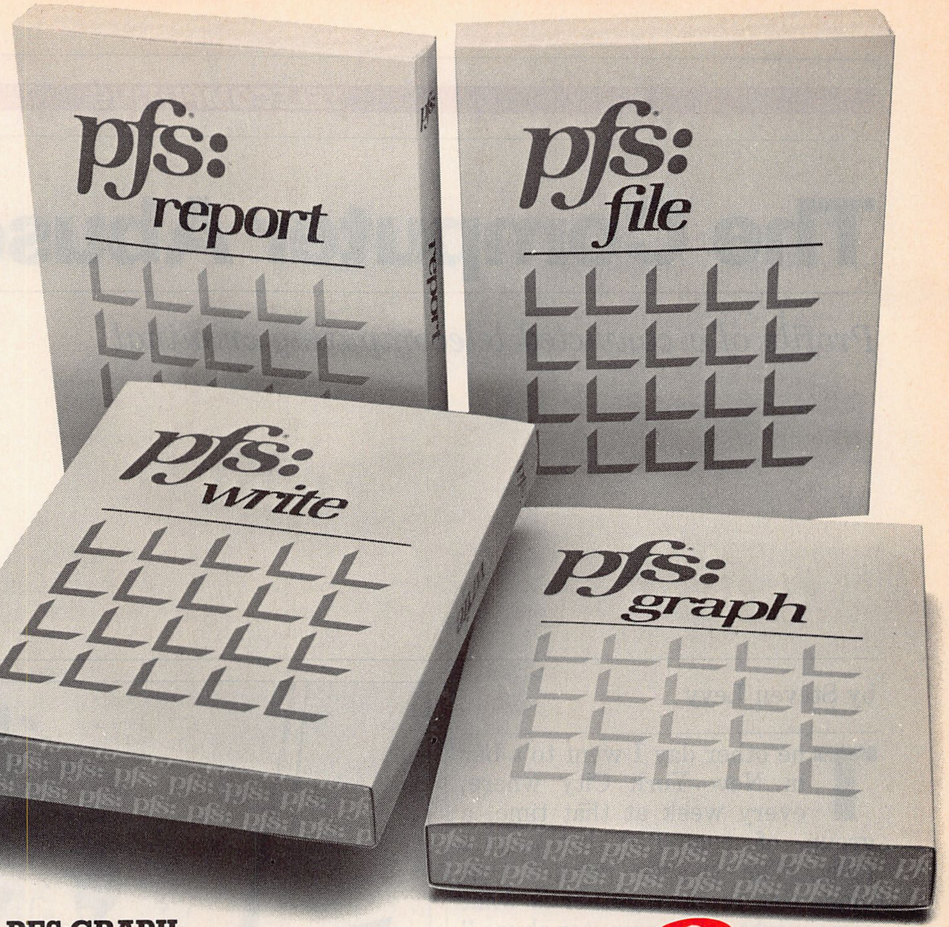

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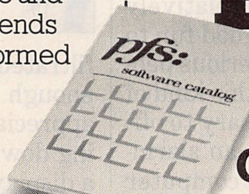

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The Computer Abuser

Profile of a convicted telecomputing criminal

by Steven Levy

The other day I went to a bar in New York City where, every week at that time, a group of computer enthusiasts meet. The specific pursuit that binds this group together is what some might call "computer abuse." Most of these people are experts in tinkering with the phone system and finding odd methods to gain access to big computers that supposedly have ways of keeping unauthorized people out.

No one was talking in whispers. The prevalent attitude was that "freaking" or "security hacking," as the group's activities are sometimes called, is relatively harmless and rollicking good fun to boot. Some of the more serious people at the table thought this kind of infiltration is even necessary to offset what they discern as an alarming centralization of computer power in the hands of The Establishment, that faceless entity which in only a few months' time will call itself Big Brother. (In fact, this group is, ironically enough, planning a party for the coming New Year's Eve to "celebrate" 1984.)

Yes, I can see their reasoning. And I know well how the information-is-or-should-be-free faction of computerists argues convincingly that closed systems are anathema to the spirit of the upcoming Computer Utopia and should be infiltrated. I also have spoken to enough unauthorized tinkerers to appreciate the exhilaration of pulling down electronic Berlin Walls in a display of technological machismo and puzzle-solving wizardry.

But I know too that my own computer and modem are fixed to the universal tangle of wires and fiber optics that make up our communications systems and that I have my own files on networks like The Source and Compuserve, both of which were mentioned casually by the group as targets that have been successfully breached. As the conversation drifted from phone company esoterica to standard hacker lore, my thoughts drifted back to a time not too long ago when I set out to get to the bottom of one tale of telecomputing crime and found something less than the carefree spirit of liberation that pervaded this particular gathering.

The Police Report

I had been doing some groundwork on a long article and hit a slow day on an otherwise busy trip to California. Idly thumbing through some newspaper clippings that someone had given to me, I came across a dog-eared wire-service story about a college student who had been arrested for misusing the San Jose State computing system. The article was

Steven Levy is a contributing editor of *Popular Computing.*

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somewhat vague, but it seemed that an incredible amount of phone bills and computer time had been illegally racked up by this student, and a considerable amount of time and energy had been spent finding him and bringing him to justice. The story was written in the standard wry tone of a general-interest reporter recounting a new kind of crime that obviously was considered "cute" by nature of its novelty.

I placed some calls to the campus and soon found myself in the office of one Sergeant Bill Lane of the San Jose State Campus Police. Sgt. Lane was a well-built, amiable fellow fluent in the matter-of-fact dialect of Cop-talk. He had in front of him what was apparently the file of this perpetrator whom I'll call Martin Arness (a pseudonym). Sgt. Lane was more than eager to talk. "Yes, we identified one individual who we were able to prosecute," he confirmed. "No doubt he was part of a network—a loose collusion among computer students in all the universities in our system."

Lane explained that computers on the 19 campuses of the California State system had recently been connected via telephone. A program called Talk was installed on each campus so that computer students around the state could stay in touch, exchange information, and share programs. The telephone line connected to computers on each campus was programmed to call only computers on the state system. "In theory, students couldn't call anywhere else." But as Sgt. Lane was later to learn, what happens when a computer becomes hooked to the outside world is often uncontrollable.

One thing that went awry was that Martin Arness—and probably others—discovered a way to get extra computer time on the network. "Each campus is allocated a certain amount of time," Lane said. "When things were tied up here, he would use, for example, the line allocated to Humboldt State's computer. The result was $7000 to $8000 worth of free telephone calls.

Computer abusers argue that closed systems are anathema to the spirit of an upcoming Computer Utopia and that they should be infiltrated.

There was much more. "Basically, Arness had found an error—a bug in the computer at the telephone company—and was gaining unauthorized time (and illegal long-distance calls) by exploiting it."

"Is all this stuff hard to do?" I asked. Sgt. Lane seemed pleased by the question. Apparently this case had made him an instant expert on the subject. "There's nothing to it. I hardly know how to turn the computer on, but I can manipulate this sucker 5000 ways," he said. "And there's almost nothing we can do about it! The more accessible you make computers to students, the more the students can manipulate them. I speak with a lot of young people, and there appears to be this underlying network of individuals who find it intriguing to manipulate the systems." He shook his head at what he obviously considered one of the more unfortunate turns of human events. "You know, you can even call the Pentagon if you know the number. It appears that there are no systems invulnerable to this sort of thing."

Sgt. Lane sighed. "Fortunately, the computer that does billing and grading on this campus has special protections. The information is on a disk that has to be physically put in at a certain time. I took a specific interest in this when I learned my paycheck was on the same computer."

I wanted more details about the crimes of Martin Arness: "Long-distance phone charges." Lane ruffled through some papers. "Sweden. All over the United States. The Republic of China. Some to Iran. He would also get on computers at all sorts of locations to communicate with people or play games. He had access to the MIT computer, where he would play Adventure and other games. That's a relatively normal thing to do, although he violated MIT's regulations getting in."

Lane leaned forward and almost whispered the next sentence. "He appeared to be participating in an MIT-centered system of people manipulating telephones—possibly a multibillion-dollar rip-off!"

Martin Arness was finicky about where he left his digital footprints. On some of the systems he accessed, users are assigned numbers. For some reason, Arness always preferred the lowest number on the system. "He would get it as a status symbol," Lane said. "If you beat him to it, he would often erase something in your file."

Erase files? How? "In almost all computers there is a master code (Lane is referring to the aspects of the system open only to those who have been given—or have stolen access to—highest priority); he must have had some of the codes. He would print out all sorts of (classified) stuff and have it put in his computer mailbox here."

Arness, says Lane, is rare only in that he was brought to justice. Lane guessed that during the course of our conversation, thousands of cases of computer abuse were occurring, all of them destined to go unpunished.

The Betrayal

Arness's downfall began with a high school girl in Nevada, Missouri. "He had met this high school girl through the MIT network. He had developed many relationships with people on computers around the country. Often, he

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would have spats with them. He tried to make these into romantic relationships.” Electronic mash notes? Worse, said Lane. “Some of the computer letters he sent had things in them you certainly wouldn't want your grade school children to read. We've looked into it, though,” Lane chuckled, “and I wouldn't be terribly surprised if some of the people he thought were women were actually men, just leading him on.”

In best detective tradition, Sergeant Lane and his crew trailed Arness to document his misdeeds and to learn more about how a person abuses computers.

In any case, the relationship with Ms. Missouri went sour, and she spilled the beans on poor Arness. Once alerted, Lane and his crew decided not to move in right away. In best detective tradition, they trailed Arness, partly to document his misdeeds and partly to learn more about how a person goes about abusing computers. But they learned something about Arness too.

“He was flunking out of school because he just about lived in the computer center. We had his habits down pretty well. Followed him to school. We knew his class schedule, but he was never there, always at the computer center. Our guy had developed a personality deficiency. His main means of talking with other human beings was by computer. When we finally arrested him, he was at his terminal. We had hoped to catch him playing with a file with secret numbers. He was playing a computer game.”

What happened to him then? “He pleaded guilty to the phone calls,” Lane told me. “I think he got 90 days in the county jail, 3 years probation. He may still be in jail. But he's not unique—20 or 30 students around here are hackers to some degree. The computer center is open all night. Everybody there has maximum opportunities to abuse the computer.”

Star-Witness Testimony

Could it be *that* bad? I headed straight to the campus computer center to find out. It was a large room in a building full of classrooms. On long tables were computer terminals, almost all in use. I found “Jimmy,” a young, dark-haired student sitting at a table marked “consultant,” and it didn't

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take long to find that he disagreed with Sgt. Lane on various points. But first he had some things to say about Martin Arness.

"He was a jerk!" The words were almost spat with disgust. "I know at least two people here who had him on their kill list! He would delete other people's files and do all kinds of stuff. He blew it for the rest of us!"

"Uh, blew it?" I asked. "What do you mean?"

"Well, let me put it this way. If you're any good at hacking, there will be some point in your career where you'll break into the system—but you'll also have the ethics not to crash the system or destroy anyone's files. He went way too far."

"He must have been pretty good at it to do all those things," I said.

"He has never impressed any of us with his programming," said Jimmy. "We avoided him like the plague. He spent a fair amount of time here. He would look over other people's shoulders and pick up passwords. He tricked a lot of people, using different names to pick up information."

Jimmy did admit that some things going on at the San Jose State computer center were not quite kosher. "Look, if you had a public phone in your house that you could use to call anywhere for free, wouldn't you use it? There was stuff here that they didn't know about." Pride had crept into Jimmy's voice.

For quite a while, I talked to Jimmy and a few other hackers who had begun to listen to our conversation. To be honest, I wasn't sure what made them maddest—that Arness's getting caught led to some sanctions against the computer center (the popular Talk program had been taken off the system) or that Arness was a rather antisocial guy whose programming skills were judged deficient. It was clear only that all of them followed a moral code somewhat more lenient than Sgt. Lane's and stricter than Arness's.

The Confession

By now, my curiosity about Arness was thoroughly whetted. I played investigator for an hour or so and finally put a dime in a pay phone to call what I had figured was the home of Martin Arness's parents. The voice that answered identified itself as belonging to Martin himself. I told him who I was and said I'd like to talk to him. After a long silence, the voice gave directions to the house.

The person who greeted me at the door was a chunky blonde whose lips curled in what I took to be part of a challenge. He seemed both angry and intrigued.

"There's a lot I can't tell you," he said, defiantly setting ground rules.

I told him not to tell me what he didn't want to.

"I'm not a typical hacker," he began. "I'm interested in the way they put things together." (From what I know, that's pretty typical of hackers, but I let him go on.) "I'd been on the (Defense Department-funded) ARPnet system, contacted the hackers at MIT, and found out from them all the things that go on."

"I heard you played some games at MIT," I said.

"Yeah. Zork, Adventure. That got stale pretty quickly."

"They said you played a lot."

I thought I saw his eyes light up. "Quite a bit," he admitted.

We got to talking about some of the other things he did. "One of the guys into security hacking told me a way of dialing out (illegally). Lots of people were doing stuff—using account numbers that belonged to other people and so on."

Martin Arness seemed to think he was singled out for the crimes of the entire group. He insisted that while he might have bent the rules a few times, he had grown out of the excesses long before he was caught. He had explanations for every charge Sgt. Lane had made. He admitted to some electronic flirting but insisted it was harmless. Yes, he logged on using

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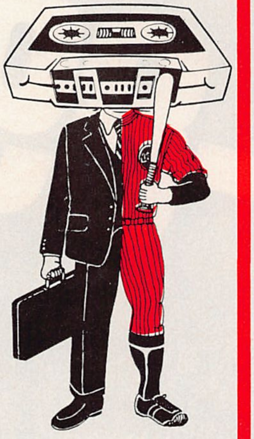

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other people's passwords, but "it was just a thing in vogue, getting into someone's account—and I didn't screw up people's files."

The only time Arness's defensiveness lapsed was when I asked him about getting the special number on the Talk program. "Yes," he said and explained that if you have the top number, you somehow can "step on" the computer conversations of others. "I was very much into getting number 1 or 13," he boasted. Then, as if Arness remembered the ordeal he had put himself and his parents through, the bright expression on his face faded. "The mentality of most Talkers isn't too high," he said quietly.

When coming to grips with institutional wrongdoing or abuses from random saboteurs, we must keep in mind that all of us, like Arness, are only human.

I didn't have much else to say to him. He'd explained that his jail term had been mercifully curtailed, and now that he was on probation, he had no definite plans. He was 21 years old. "If I ever get the money together, I'll buy a computer," he mused. "I'm seeking a job in that field." Martin paused as the irony reverberated through the dimly lit living room of his parents' house.

"It's the only thing I know how to do," he said.

I don't know if Martin Arness ever did get a job in computers. Maybe he got back into college. Maybe he's a consultant for American Bell. In any case, it was Martin I was thinking of when I said goodbye to my drinking partners at the Greenwich Village bar the other night. I figured that a full recounting of Martin's story would have thrown a pall on the proceedings.

The Dark Side

But sooner or later we have to discuss it: the dark side of telecommunications as well as the bright side. And we must come to grips with the possibility of institutional wrongdoing as well as abuses from random saboteurs who veer from the do-no-evil hacker code. It will be important during these discussions to keep in mind that all of us are only human, and here I refer to Martin, 21 years old, as I left him in that house in San Jose, asking me to send him a copy of the article. Somehow I suspect he'd be just as happy if I didn't. □

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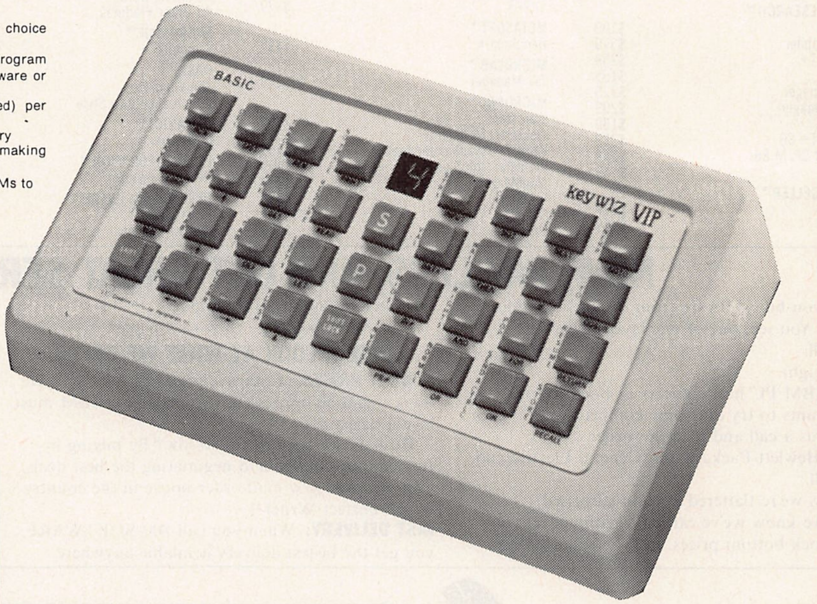

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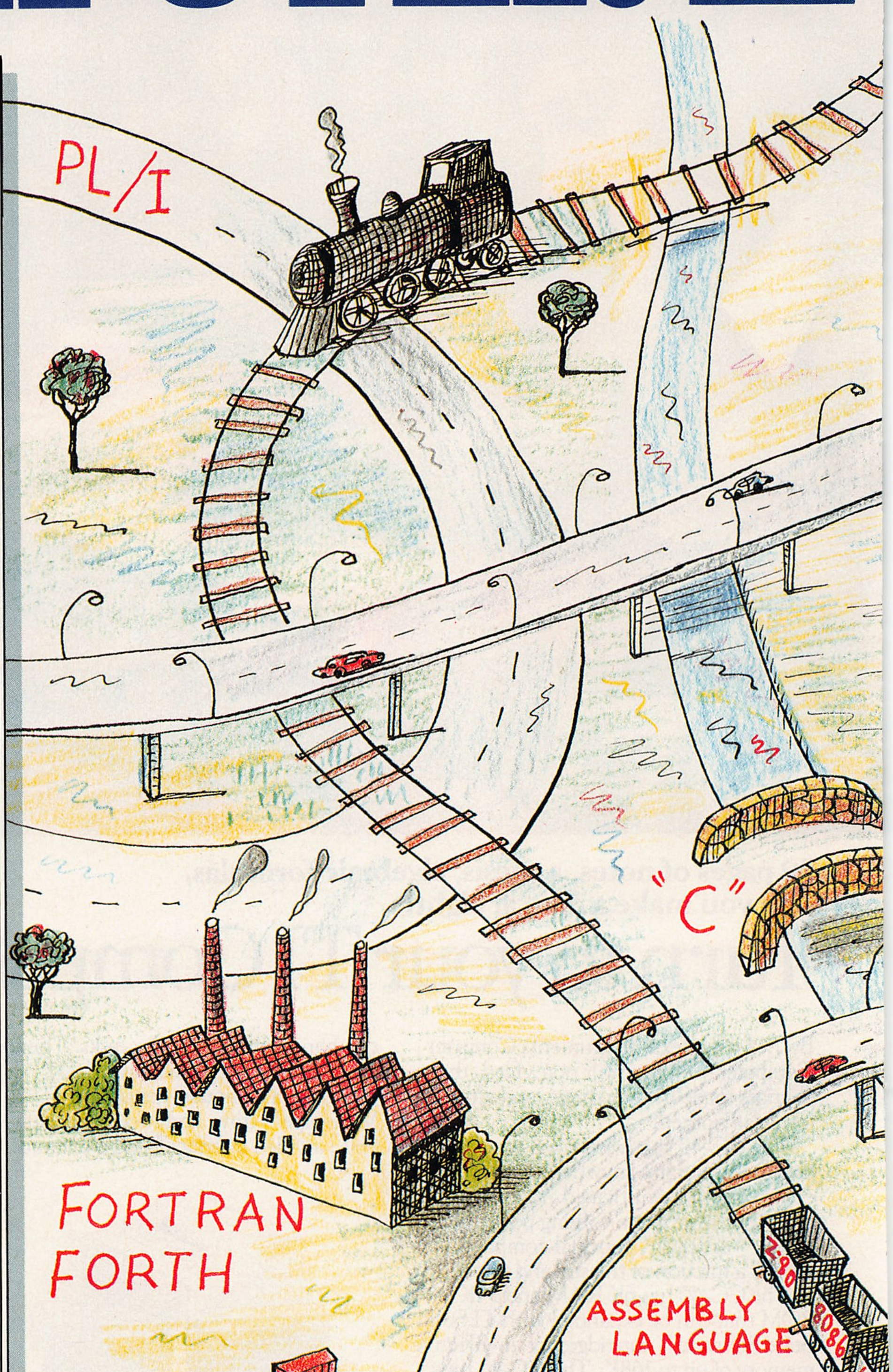
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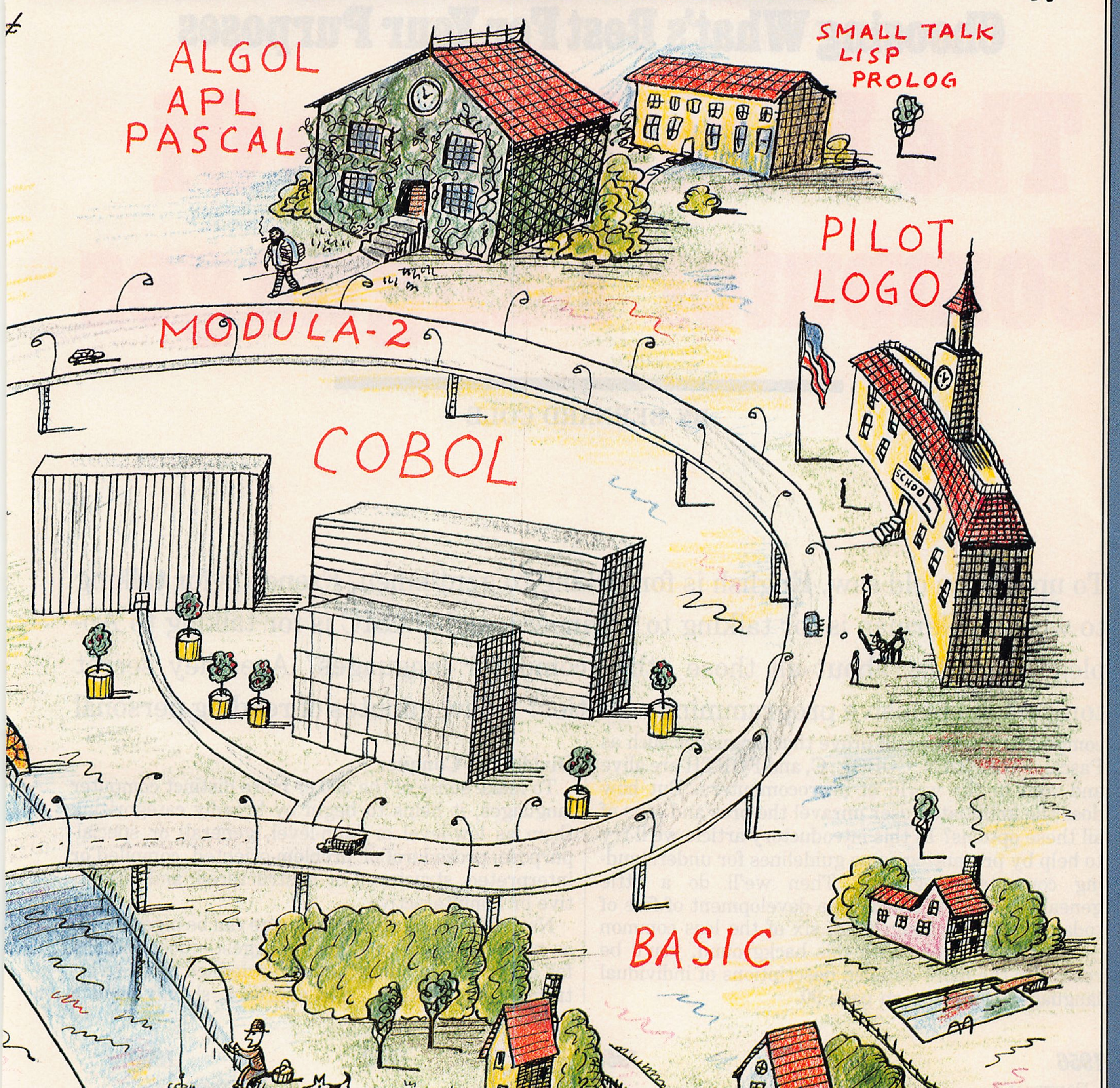
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Choosing What's Best For Your Purposes

The Family Tree Of Computer Languages

BY BERNARD COLE

To update an old saw, English is for talking to gentlemen, French is for talking to women, German is for talking to engineers, and BASIC is for talking to Apples. But what about all those other computer languages? Are they secret tongues of exclusive programming societies? A few minutes of reading personal computer literature will prove that languages such as Pascal, FORTRAN, COBOL, C, and FORTH are alive and well in the world of microcomputers. But how does the uninitiated user unravel the pros and cons of all these options? In this introductory article we'll try to help by presenting some guidelines for understanding computer languages. Then we'll do a little genealogical work, tracing the development of five of today's major languages and six of the less common cybernetic tongues. With this background, you'll be ready for the more detailed descriptions of individual languages beginning on page 90.

Divide and Conquer

To make sense of the 200 or more distinct computer languages, it helps to begin by broadly categorizing them as low-level or high-level, general- or special-purpose, procedural or problem-oriented, compiled or interpreted, structured or unstructured, and interactive or noninteractive.

Naturally, no computer language can be pigeonholed as neatly as these categories suggest—most actually fall at some point along the ranges defined by those extremes. Nonetheless, this approach should yield a

1956
FORTRAN

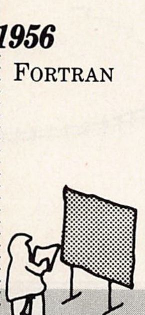
1957

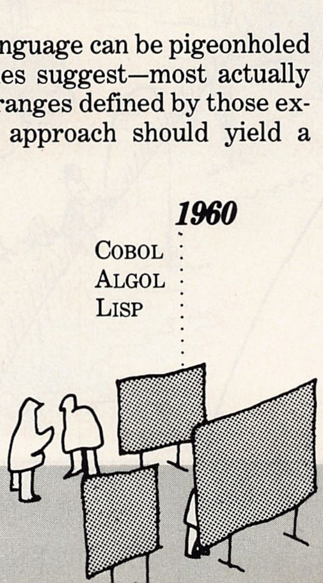
1958

1959

COBOL
ALGOL
LISP

1960





valuable overview of both the individual languages as well as their relationships to one another.

Low-level versus high-level: Low-level languages give programmers direct control over details of computer hardware such as memory locations, microprocessor registers, and input/output ports. High-level languages distance programmers from these details, forcing them instead to work with abstractions such as files, arrays, and variables. The lowest level is machine language, and the highest level (at least in theory) is a "natural language" like English.

To appreciate the benefits and drawbacks of a low-level language take a look at machine language, the most fundamental way of communicating with a computer. It consists of a microprocessor's instructions represented in binary form as on-off patterns of microelectronic switches. Assembly language is one step higher than this level; it uses alphabetic abbreviations for instructions and symbolic names for memory circuits and data. Compare a machine-language command (00100001 10001111 00001000) with an assembly-language command (LD HL,MEMLOC) and its meaning (load register HL with the value of the variable MEMLOC). Programmers can work more accurately and efficiently in assembly language than in machine language; an assembler program translates their assembly-language code into machine language.

Machine or assembly language provides almost total flexibility in tapping a computer's capabilities. For example, a section of program code may be treated as data or vice versa, and program code can even be modified while a program is running. Machine-language programs can harness the specific strengths of a particular microprocessor and its input/output facilities. In applications such as systems software (operating systems and the like), this level of efficiency and flexibility is mandatory.

On the negative side, low-level languages require a great deal of technical knowledge and attention to detail, creating potential stumbling blocks for beginning programmers. Even professional programmers find assembly-language programming slow work compared to programming in high-level languages.

High-level languages, in contrast, take care of the hardware details automatically and allow the programmer to think in terms of the application at hand. The single BASIC command PRINT USING "###.##"; I/100 might replace scores of machine-level instructions. However, with this convenience comes an inevitable loss of efficiency and flexibility. Few high-level programs can attain the speedy performance of machine-language code. A few languages such as C and FORTH offer some of the efficiency of machine language together with the power of high-level languages. However, these languages are not well suited to the beginning programmer.

General- versus special-purpose: Most languages are created to serve specific purposes such as teaching programming concepts, controlling industrial robots, or creating graphics. However, many languages are extraordinarily flexible, and their ultimate uses far exceed the concrete plans of their designers.

General-purpose languages include BASIC, FORTRAN, COBOL (business data processing), LISP (list processing), and, more recently, ALGOL, Pascal, APL, and PL/I. The majority of programming applications have been written in BASIC, FORTRAN, or COBOL.

Special-purpose languages, on the other hand, enable programmers to solve narrowly defined problems or unusual applications such as systems programming, where one must be able to control the details of the hardware. Special-purpose languages include C, FORTH, Modula-2, and Smalltalk—all for systems programming—PILOT for computer-aided instruction, and PROLOG for logic programming.

Procedural versus problem-oriented: Procedural programming languages require the user to specify a set of operations to be performed in a specific sequence. Unlike native machine and assembly languages that require instructions in a form very specific to a particular microprocessor, procedural languages are designed to be independent of particular

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Bernard Cole is a freelance writer living in Berkeley, California.

1961

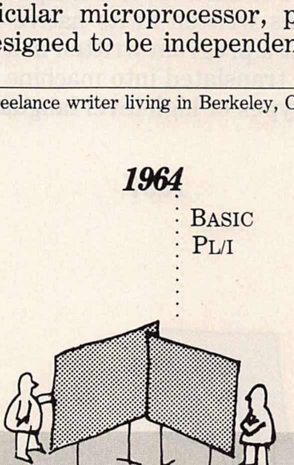
1962

1963

1964

BASIC
PL/I

1965



machines. These languages relate to the procedures being coded, not to the specifics of the computer's architecture. A program written in a procedural language can be executed on any computer that has a translator for that programming language. Most of today's general-purpose languages are procedural.

While a procedural language specifies how something is to be accomplished, a problem-oriented language specifies what is to be accomplished. The closer the programmer can come to stating a problem without specifying the steps that must be taken to solve it, the more nonprocedural the language. Examples of such problem-oriented languages are program generators such as System 80, The Tool, Savvy, and The Last One.

Many professionals who program in procedural languages say that problem-oriented systems are not programming languages at all and that their use does not qualify as true programming. But according to James Martin, author of *Applications Development Without Programmers* (Prentice-Hall, 1982), and other experts who have studied the issue, the net effect of problem-oriented programming is exactly the same as any other sort of programming. Just as high-level procedural languages were developed to relieve programmers of the burdens of dealing with machine-level coding, problem-oriented languages make it unnecessary for the user to get involved in specifying the programming steps that must be taken to solve a problem. Moreover, just as procedural languages generate object code written in the computer's machine language, so problem-oriented systems now available for personal computers generate programs written in a particular symbolic code, whether assembly or procedural.

Interpreted versus compiled languages: On the most basic level of hardware, a computer can execute only instructions written in its native machine code. This means that a program written in a high-level language must be translated into machine code before it will run. Two types of high-level language translators can do this: compilers and interpreters. A compiler performs the translation in two steps. It first translates the whole program into machine language, and then the machine-language version is executed by the computer. An interpreter performs the operations contained in the program as it reads them line by line, using a built-in dictionary that gives machine-language equivalents of high-level commands.

While the interpreter must repeat the translation of a given statement every time it occurs—a rather inefficient process—the compiler can repeat the necessary statements without translating each time, a much faster process. The drawback of the compiler is that it makes it difficult to modify or alter statements within the program. Usually the entire program must be translated over again if changes are required. Thus for programs undergoing changes, revisions, or improvements, which is often the case for the inexperienced programmer, an interpreted language is better because it permits interaction with the program during execution and makes changes immediately.

Depending on the specific application, various programming languages tend more toward one approach than the other. COBOL and FORTRAN are usually compiled while APL is generally interpreted. Of the available BASIC translators, about half are compilers and half interpreters.

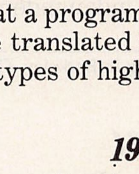
Structured versus unstructured: Here we're dealing not so much with characteristics of particular languages as we are with the qualities of programs themselves, whatever the language they're written in. Lately much discussion has focused on the pros and cons of structured programming, but all computer programs have *some* sort of structure. A more accurate distinction is between good (logical) structure and bad (illogical) structure.

In the same way that it's relatively easy to learn the grammar and syntax of a foreign language like French or Spanish, it's not too difficult to master the basics of a particular programming language. What is not so easy is writing a program in a clear, logically organized manner.

1966

1967

APL



1968

1969

1970

According to Kenneth Orr, author of *Structured Systems Development* (Yourdon Press, 1977), a program is well structured if (1) its routines and subroutines are in a modular form in which each module is a program segment containing a complete, logical thought; (2) its modules are hierarchically organized in such a way that within each module there are nested logical subunits that are themselves structured and contain further subunits; and (3) it uses straightforward, readable code rather than slightly more efficient but obscure code.

A well-structured program has at least four advantages. It is easier to debug during development because the logical connections between various instructions, routines, and subroutines can be clearly seen; it is more likely to be correct the first time around because of the care that went into its design; it usually takes less time to create because it has fewer bugs to find and fix; and it is far easier to *maintain*, that is, to update or correct at a later date.

Most programming languages allow you to design well-structured programs, and numerous books explain how to do it. But what many programming languages (especially the older ones) also allow is the design of poorly structured programs. Only the newer computer languages such as Pascal and recent revisions of older languages such as SBASIC actually *prevent* you from using procedures that lead to illogical program structures. Many of the problem-oriented program generation languages require that you enter information about your application in a logically structured way.

Interactive versus noninteractive: As with structured programming, the advantages here all lie on the side of interactive languages. Surprisingly, though, of the traditional general-purpose procedural languages only APL and BASIC were designed from the start for interactive operation. Moreover, Logo, PILOT, and Smalltalk are the only members of the newer generation of languages that may be characterized as truly interactive.

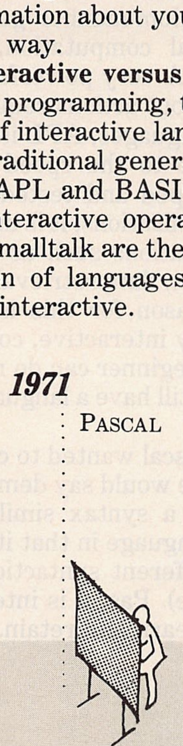
In an interactive language you can communicate directly with the computer both when you're typing in the program and when you're running it. In addition to faster response time, here are a couple of other advantages that would lead one to choose an interactive language:

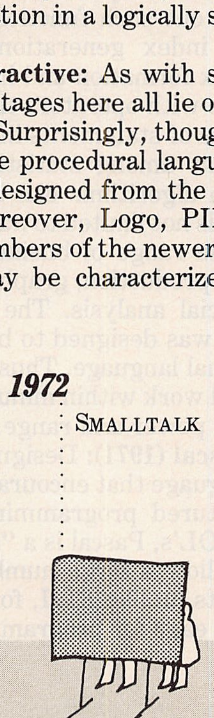
- *Interactive editing:* The process of developing a program alternates between running the program and changing or editing to correct the errors the preliminary runs turn up. While noninteractive languages separate the editor and the translator, the interactive program integrates the two, eliminating a number of time-consuming intermediate steps.
- *Immediate error detection:* If you type an incorrect line, a good interactive language will report it immediately. You can then correct the error while the purpose of the line is still in your mind. If the error was due to a misconception that you corrected, you also avoid repeating the error on subsequent lines. Noninteractive programs support the detection and subsequent correction of errors only after the entire program has been typed in.

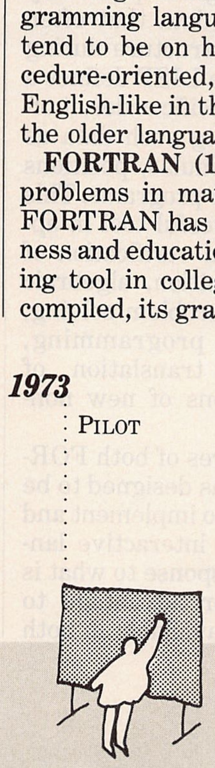
A Brief Survey

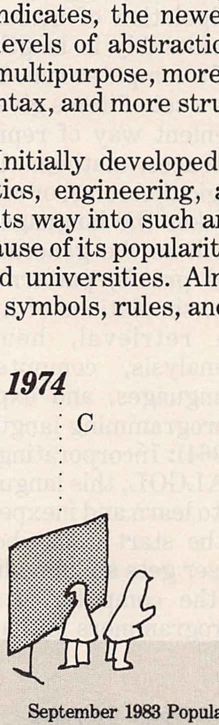
Each programming language, of course, does not fit neatly into one or another of the broad types we've defined. Most languages fall into more than one of the categories. This is particularly true of the more recently developed programming languages, and the categories are likely to get fuzzier in the future. As the following chronological survey of widely used programming languages indicates, the newer languages tend to be on higher levels of abstraction, less procedure-oriented, more multipurpose, more natural and English-like in their syntax, and more structured than the older languages.

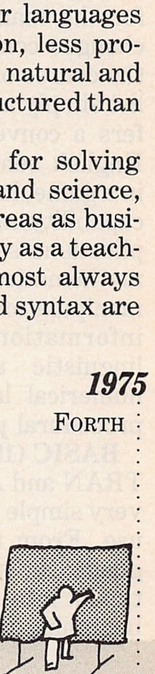
FORTRAN (1956): Initially developed for solving problems in mathematics, engineering, and science, FORTRAN has found its way into such areas as business and education because of its popularity as a teaching tool in colleges and universities. Almost always compiled, its grammar, symbols, rules, and syntax are











Innovative languages were part of computing's New Frontier in the early '60s, when COBOL, LISP, and BASIC were developed.

similar to mathematical and English-language conventions. FORTRAN treats arithmetic operations with commands that evaluate expressions and substitute the results for current values of variables. String manipulation in FORTRAN is difficult but not impossible. Graphics-processing programs, database management systems, and word-processing programs all have been written in the language.

COBOL (1960): Developed specifically for business and commercial applications, COBOL is characterized by programs stated in precise, easily learned natural words and phrases that can be read by nontechnical users. The language offers many important file-organizing features and can deal with variable data lengths. Input/output procedures and report generation are its strong points.

ALGOL (1960): A particularly powerful language, ALGOL was originally developed as a general-purpose language for expressing formal problem-solving procedures known as algorithms. Although similar to FORTRAN, it is more comprehensive and flexible. Also, thanks to its more formal structure it poses fewer exceptions and is more readable.

LISP (1960): Featuring impressive list-processing capabilities, LISP is the choice of researchers in artificial intelligence. The language is designed specifically for the manipulation of nonnumeric data that often changes considerably in length and structure during the course of a computer run. Because LISP defines a list simply as a set of items given a specific order, it offers a convenient way of representing such data as English sentences, mathematical formulas, positions in a game, logic theorems, or computer programs. This capability makes the language a powerful tool in applications such as the generation and verification of mathematical proofs, pattern recognition, algebraic manipulation, simulations of human problem solving, information retrieval, heuristic programming, linguistic analysis, computerized translation of numerical languages, and explorations of new nonprocedural programming languages.

BASIC (1964): Incorporating features of both FORTRAN and ALGOL, this language was designed to be very simple to learn and inexpensive to implement and use. From the start it has been an interactive language; the user gets an immediate response to what is typed into the computer. Its major advantage to beginning programmers is that it is available in both interpreted and compiled versions. In an interpreted version, anyone can write a program and then inspect, modify, and correct it with a minimum of inconvenience. Microcomputer versions of BASIC have increased in power to the point that today they are more than adequate for a large number of business and commercial applications.

PL/I (1964): Designed as a multipurpose programming language for solving both business and scientific problems, PL/I incorporates features of both FORTRAN and COBOL. On the FORTRAN side PL/I has simple, concise statements, but like COBOL it has the ability to manipulate and input or output grouped records or files quite easily. It uses basic building blocks called procedures, which are blocks of instructions designed to perform stated functions. One procedure can be hierarchically incorporated into another, and any data declared in a procedure is automatically available to all procedures nested within. PL/I can handle strings of alphanumeric characters or strings of bits. It also allows programmers to describe data in terms of arrays and other sophisticated "pointer" structures.

APL (1967): Among the general-purpose procedural languages available for personal computers, APL has the most comprehensive set of primitive operators to carry out such functions as random-number generation, index generation, factorial computation, and matrix formation and inversion. A very powerful language with operators that carry out actions requiring dozens of statements in other languages, APL is very popular among statisticians due to the speed with which algorithms can be developed and tested. But APL is not limited to numeric applications; it is used in a wide range of business applications such as document production, graphic analysis, data retrieval, and financial analysis. The main reason for this is that APL was designed to be a highly interactive, conversational language. Thus even a beginner can do meaningful work within minutes and still have a language of great power and range.

Pascal (1971): Designers of Pascal wanted to create a language that encourages (some would say demands) structured programming. With a syntax similar to ALGOL's, Pascal is a "small" language in that it does not allow a large number of different syntactic constructs (unlike PL/I, for example). Pascal is intended to be easy for programmers to learn and retain.

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> **M**any of the noteworthy languages created in the 1970s—especially FORTH and C—were designed with systems programming in mind.

Smalltalk (1972): Conceived as a tool kit that would enable students and teachers to explore a subject or solve a problem, Smalltalk uses a wide range of graphic "objects." As little as a year ago Smalltalk could be considered a special-purpose language used almost exclusively in the academic research world, but now that a number of business-oriented computer manufacturers (including Apple) and software designers (such as Visicorp) have used it in their newest products, it could well be on its way to a place in the mainstream of general-purpose applications languages.

PILOT (1973): Originally designed to introduce children to the fundamentals of computer performance, PILOT is now most often used in writing programs for computer-aided instruction in all subjects. It is especially tailored for such instructional tasks as drills, tests, and dialogues and allows convenient comparisons between words or portions of words. PILOT is not a good choice for complex computational problems.

C (1974): A structured programming language that lends itself to systems programming as well as to more mundane programming tasks, C produces code that approaches machine language in density and efficiency while still offering some high-level language features such as structured programming and systems programming capability. A C compiler is simple, compact, and easily written—a professional programmer using current technology can prepare such a compiler for a new machine in no more than a few months. Because C is independent of any particular machine's architecture, it is suitable for writing portable programs.

FORTH (1975): Like C, FORTH is a kind of a high-level assembly language designed for systems programming. FORTH is unusual in that it offers many interesting features not normally associated with interpreted languages, such as allowing you to add new commands. It maintains a system library of command calls that is actually a list of addresses of routines that execute the commands. You can use any of the existing library commands to build up more complicated ones.

FORTH is not as fast as assembly language, but it's much faster than interpreted BASIC. Its special features allow you to customize the language for a specific application. By defining new special-purpose commands and adding them to the library, you can make FORTH into a language that conveniently meets your particular needs. For example, if a statistical language is required, the necessary functions can be added to the library and subsequently used as new commands. Similarly, the library could be easily customized for sophisticated electronic filing or complex financial calculations.

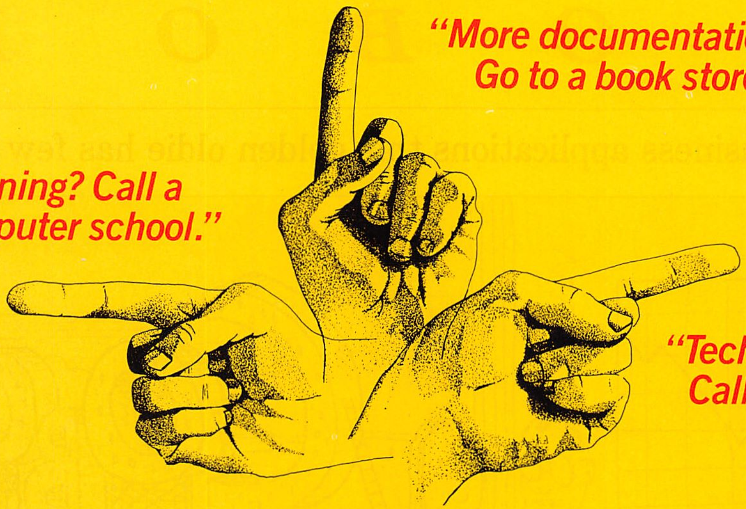
What the Future Holds

It is clear that over the short term traditional procedural languages will continue to dominate in most personal computer applications. Experts expect that such languages will continue to evolve and that major new languages will be introduced occasionally.

Despite the enormous increase in the number of personal and small-business computers, development of programming languages will be much slower than in the past. This is because the rapid proliferation of personal computers has drastically changed the environment in which programming languages are developed. On the one hand, software companies that find themselves unable to produce enough canned programs to satisfy the demands of all the new users of computers are looking for ways to increase the productivity of their professional programmers. On the other hand, though, many personal computer users want to write their own programs but have neither the time nor the inclination to learn a procedural dialect.

According to the experts, these demands will favor greater development of nonprocedural program generation languages. Such software packages are now becoming available for use on personal computers. A good example is The Last One, which generates BASIC source code.

One drawback (if it can be called that) of these first-generation program generators is that they relieve you of the coding only. You still have to go through the process of developing the overall design of the program. Indeed, such nonprocedural program generators literally force the user into designing a structured program. As such, they are not for the old-school, seat-of-the-pants professional programmer or for the novice programmer who is unfamiliar with structured programming. Artificial intelligence research centers and software companies are working on "expert systems" that not only relieve you of the coding but also help you structure programs. We can expect such expert systems to hit the market within a few years. □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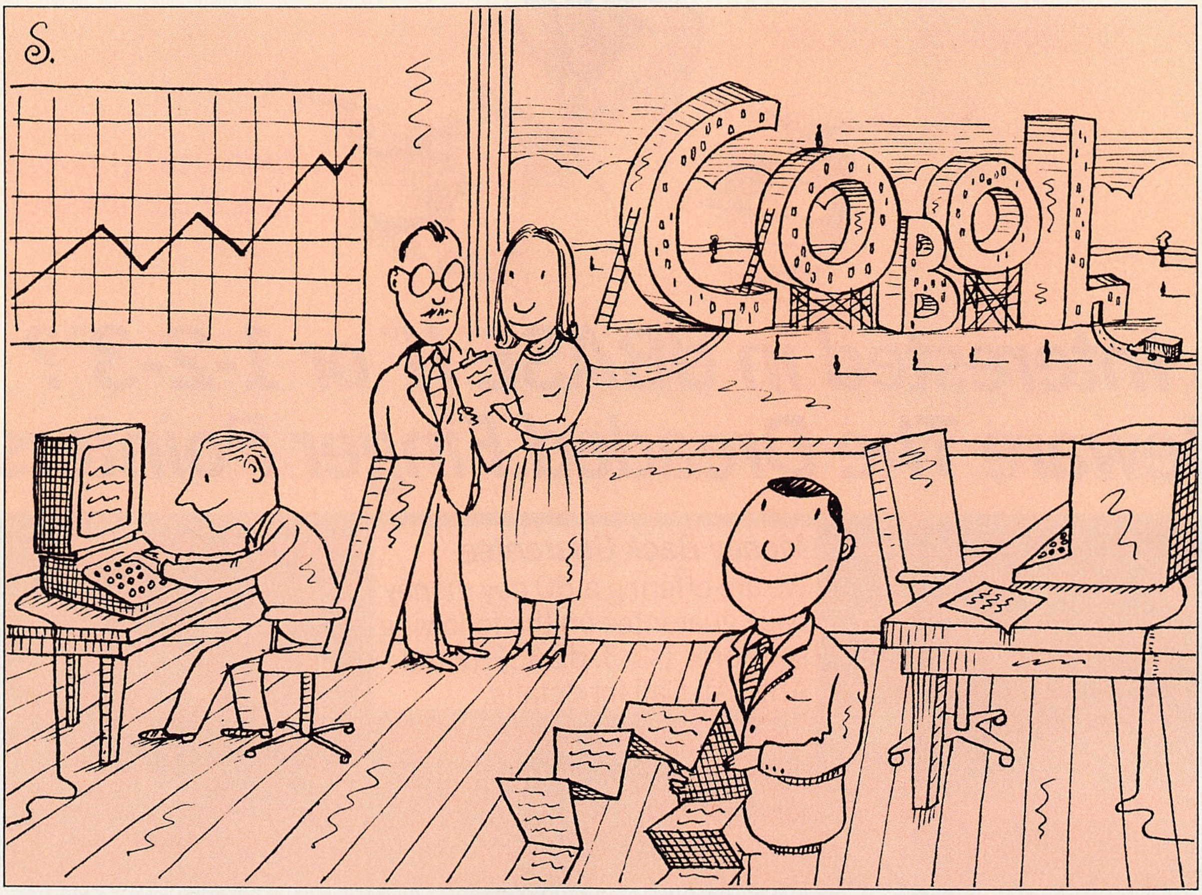

BY GLENN EMBREY

The recent reports of COBOL's demise, to paraphrase Mark Twain, have been greatly exaggerated. Criticizing COBOL has been fashionable since its invention in 1960—the language is said to be old-fashioned, cumbersome, and inelegant. But all that criticism doesn't alter the fact that if you're interested in making money as a programmer, COBOL is still your best bet. In the Los Angeles area at least, ads for COBOL experts regularly outnumber by at least three to one the ads for programmers in all other languages combined.

This need for COBOL programmers continues for two reasons. One is that the enormous investment the world has already made in COBOL code makes the language self-perpetuating. The other is more basic: COBOL is very good at what it does.

Estimates vary widely, but even the most conservative ones indicate that over 65 percent of the lines of code used in today's data-processing departments are written in COBOL. Because few businesses can afford the luxury (some would say insanity) of paying *two* programming staffs—one to tend the COBOL programs already in use and the other to write and maintain programs in other languages—new programs are written in COBOL as well, thus assuring a continued need for experts in the language.

The second reason for COBOL's tenacity is usually ignored by its critics. More than 20 years after it was

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Glenn Embrey is Director of Corporate Communications for the Ryan-McFarland Corporation in Rolling Hills Estates, California.

Illustration by Jean-Claude Suarès

> Because of the long life and large size of most business programs, more time is spent maintaining them than went into writing them in the first place.

written, COBOL is still one of the best languages for doing what it was designed to do: business data processing.

It's important to understand that COBOL is not a good general-purpose language, nor was it meant to be. Because it was designed as a specialized tool from the start, it includes features that enable it to do a superior job of handling the vast amounts of data and performing the endless routines common to business computing.

COBOL grew out of a 1959 meeting of representatives from government, business, academia, and the growing computer industry. All were interested in developing a high-level programming language for business use that would be close to standard English and could produce machine-independent applications. The language created to meet these goals was called COBOL, for COmmon Business-Oriented Language. (It is "common" in the sense of being common to many different computers.) The major characteristics and features of COBOL are the results of its design goals.

English-Like Readability

The most immediately noticeable quality of COBOL is how much it looks like normal English. Because COBOL words can be up to 30 characters long, it is easy to write this sort of code:

```
IF EMPLOYEE-SALARY IS GREATER THAN 1000,
  PERFORM CHECK-SALARY-FOR-ERROR-ROUTINE;
  IF THERES-A-SALARY-ERROR,
    PERFORM UPDATE-ERROR-REPORT-ROUTINE,
  ELSE
    PERFORM WRITE-EMPLOYEE-CHECK-ROUTINE.
```

You don't have to be a programmer to figure out that this bit of code says to double-check the salary before issuing a paycheck for more than a thousand dollars.

For obvious reasons, COBOL's English-like readability is one of its major attractions. Managers and other businesspeople who have a stake in what the program does but who aren't programmers themselves can understand what is going on. This makes them feel a lot better, and it also makes programming a task that can be overseen by business managers rather than programmers.

Another bonus of COBOL's readability is that beginning programmers can get started quickly. This is not to say that you can master COBOL in a short period; on the contrary, it takes a long time to learn all the capabilities of the language. But you can *begin* programming relatively quickly. Likewise, programming itself is easier when the code is easy to understand. You don't have to keep figuring out what a section of code was designed to do.

Not so obvious but perhaps most important is that COBOL's English-like code makes programs more maintainable, and maintenance is the name of the game in business applications. (*Maintaining* a program involves fixing bugs, adding features, altering routines, changing data, or any number of other activities needed to keep the program responsive to current needs.)

Because of the long life of business programs (five years is not unusual) and because of their length (often many thousands of lines of code), more time is spent maintaining them than was spent developing them in the first place. Most often, someone other than the program's original authors will be involved in the maintenance, making it essential to be able to find out what a program does and how it does it.

Program documentation is supposed to provide this information, but as most programmers will gladly tell you, they hate to write documentation. Most of them hate to *read* it as well, claiming that it's usually worse than no documentation at all. (Often they're right, given the sorry state of most documentation.) The solution to this problem is to make the code self-documenting, a COBOL capability the earlier example demonstrates. With this approach, documentation is always accurate and up-to-date.

A number of factors contribute to COBOL's readability. I've already mentioned one: words can be 30 characters long. Another is that algebraic symbols may be written out (although the symbols themselves can be used). "Noise" words that may be included but aren't necessary (like IS in IS GREATER THAN) add to readability too.

Also, COBOL syntax *looks* like English. COBOL statements, which can be punctuated with commas or semicolons, are combined to form sentences that end with periods. Related sentences are grouped together into a paragraph with a heading describing its function, and even larger groupings are possible.

COBOL's readability is enhanced even further by a

COBOL excels at performing numerous straightforward operations on the enormous amounts of data often found in business computing applications.

feature that allows you to assign a descriptive name to a specific condition and then use that name in place of the condition. This lets you write very clear conditionals such as IF THERES-A-SALARY-ERROR. Contrast this to IF ERROR-FLAG = 1, or worse, IF EF = 1. Eventually someone will have to hunt through that sort of enigmatic program to find out what 1 or EF signifies.

Although COBOL was created before the advent of structured programming, it is possible to use structured programming techniques in working with the language, once again making maintenance easier. The keys to writing structured COBOL code are the PERFORM verb and IF . . . ELSE conditionals.

The PERFORM verb passes control temporarily to another part of the program. Once the appropriate portion is performed, control is returned to the section of the program that issued the PERFORM. The portion referred to by the PERFORM may be a single paragraph, a series of consecutive paragraphs, or an entire program section. You can designate the number of times you want the routine performed, a condition for terminating the routine, a length of time for the routine to continue, and other such conditions.

The conditional statement is another feature that enables you to write structured COBOL programs. The basic format of COBOL conditionals is:

```
IF (condition),
   (imperative),
ELSE
   (imperative)
```

Multiple conditions may be specified after the IF (for example, IF AGE IS GREATER THAN 50 AND SALARY IS LESS THAN 1000). Multiple imperatives are also possible, including multiple PERFORM routines. The potential power and complexity of the construction is increased by the possibility of nesting IF statements within one another (the first example of code in this article is a very simple version of a nested conditional).

Data Handling

The second major strength of COBOL is its ability to handle vast amounts of data. Preeminently a record-processing language, COBOL is adept at storing, retrieving, organizing, manipulating, and printing information. Because business computing consists mainly of performing a lot of straightforward operations on enormous collections of information, COBOL serves very well.

These impressive data-handling capabilities are a result of how extensively and precisely COBOL allows you to describe data. After it is described in such detail, data can then be accessed and manipulated at the highest, most general level of description or any-

COBOL Developers

COBOL compilers for microcomputers may be purchased separately or as parts of complete systems. Either way, most compilers have been written by one of three companies: Ryan-McFarland Corporation, Micro Focus Inc., or Microsoft Corporation.

The compilers these companies produce are available to individual users primarily from independent software dealers or computer retailers, although some Microsoft products are available directly from the company itself. You can contact the companies at these addresses for information about dealers carrying their products:

- Ryan-McFarland Corp., 609 Deep Valley Dr., Rolling Hills Estates, CA 90274; (213) 541-4828. RM/COBOL is available on virtually all popular microcomputers. Prices vary according to dealer and target system—suggested list price is $750 for 8-bit machines.
- Micro Focus Inc., Suite 235, 1860 Embarcadero Dr., Palo Alto, CA 94303; (415) 856-4161. CIS COBOL is also available on almost all popular microcomputers. Prices vary depending on the particular implementation; suggested list prices begin at about $850.
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For example, a record for a credit-card customer might carry hundreds of pieces of information, including name, address (subdivided into street address, city, state, and zip code), credit limit, current balance, and the amounts, dates, and department numbers of the most recent purchases. Once defined, each piece of information can be manipulated (as in changing a zip code or updating the current balance) without affecting any other portion of that customer's record. The entire record can be accessed via one or more of the pieces of information. You could print out a listing, for example, of all customers in a given zip code who have balances of more than $500 or of all customers who spent more than $50 in the lamp department last month. The possibilities afforded by this powerful capability are virtually endless.

As you might imagine, COBOL has extensive table or matrix features to support its data-handling prowess. Tables of up to three tiers or dimensions can be created and searched very efficiently with just a few lines of code. Similarly, COBOL is capable of handling sequential, relative, and indexed data files.

To support the large number of reports any business generates, COBOL has features that enable you to format reports and edit information very quickly. Among other things, you can suppress leading zeros, add decimal points (or change them to commas for European reports), assign plus or minus signs, and manipulate dollar signs (or substitute other currency symbols for them)—each with no more than a single line of code.

Unlike most other languages, COBOL requires that all data be described separately from the algorithm portion of the program. A look at the data division in a COBOL program, therefore, will show you detailed descriptions of all of the data involved. This is a great convenience for programmers and nonprogrammers alike. Also, the same data description can be shared by different programs. Using the COBOL COPY statement, you can transfer the data division of one program to another. This facilitates coding by teams of programmers on single or multiple applications.

As evidence of how successful COBOL's data-handling features are, you'll note that most subsequent languages and database management systems have emulated them.

Standardization

COBOL's designers were especially concerned with creating a system that allowed machine-independent programs. Many of them had firsthand experience with the frustration and expense involved in having to

Sample COBOL program

```
DATA DIVISION.
WORKING-STORAGE SECTION.
01  EMPLOYEE-CHECK-RECORD.
    05  EMPLOYEE-NUMBER                  PIC 9(7).
    05  EMPLOYEE-NAME                    PIC X(30).
    05  EMPLOYEE-ADDRESS-LINE-ONE        PIC X(30).
    05  EMPLOYEE-ADDRESS-LINE-TWO        PIC X(30).
    05  EMPLOYEE-AMOUNT-TO-BE-PAID       PIC 9(6)V99.
    05  EMPLOYEE-PAYMENT-DUE-DATE.
        10  EMPLOYEE-PAYMENT-YEAR        PIC 99.
        10  EMPLOYEE-PAYMENT-MONTH       PIC 99.
        10  EMPLOYEE-PAYMENT-DAY         PIC 99.
    05  EMPLOYEE-YEAR-TO-DATE-PAID       PIC 9(7)V99.

PROCEDURE DIVISION.
PROGRAM-CONTROL-PARAGRAPH.
      OPEN INPUT EMPLOYEE-CHECK-FILE.
      OPEN OUTPUT CHECK-PRINTER.
      PERFORM FORMS-LINE-UP.
      PERFORM GENERATE-EMPLOYEE-CHECKS
        UNTIL END-OF-FILE.
      PERFORM CHANGE-FORMS-ON-PRINTER.
      PERFORM PRINT-EMPLOYEE-CHECK-REGISTER.
      CLOSE EMPLOYEE-CHECK-FILE.
      CLOSE CHECK-PRINTER.
      STOP RUN.

PRINT-AMOUNT-ON-CHECK.
      MOVE EMPLOYEE-AMOUNT-TO-BE-PAID
        TO CHECK-DOLLAR-AND-CENTS-AMOUNT.
      MOVE EMPLOYEE-AMOUNT-TO-BE-PAID
        TO WORK-TOTAL-AMOUNT.
      MOVE WORK-DOLLAR-AMOUNT
        TO CHECK-DOLLAR-AMOUNT.
      MOVE WORK-CENTS-AMOUNT
        TO CHECK-CENTS-AMOUNT.
      MOVE CHECK-DOLLAR-AMOUNT-LINE TO CHECK-LINE.
      PERFORM PRINT-ROUTINE.
```

COBOL was designed to handle business data processing, which ordinarily involves a very long series of straightforward operations on large amounts of data. Although it is possible to write short programs in COBOL, such programs are not good examples because they don't illustrate the more powerful features of the language.

The above samples are small portions of a much longer check-writing program. The first sample, found in the program's data division, describes one of the numerous records involved in the program.

All other records used by the program are handled in similar fashion. The PICTURE (or PIC) clause specifies the kind and number of characters in each field. For example, PIC 9(7) indicates a numeric field of seven characters.

The second and third samples are part of the procedure division that defines the program's *algorithm* (all of the operations—and their sequence—required to accomplish what the program is intended to do). The program-control paragraph sits at the beginning of the procedure division, and as its typically descriptive name implies, this is the segment of code that runs the entire show, branching to each major operation in the necessary order.

Each of these operations may require branching to numerous lower-level operations, which in turn will call on other low-level routines, which call on others, and so on. For example, the generate-employee-checks routine that the program-control paragraph branches to will eventually require the print-amount-on-check routine (third sample) to be performed.

This third sample moves some of the salary information found in the employee-check-record into a storage area that is printed by the print-routine paragraph called by the last line. Because of the way this storage area has been defined earlier in the program, the final result is that a line like the following will be printed in the appropriate area on each check:

```
***345DOLLARS.34CENTS                $345.34
```

Of course, much easier and quicker ways of writing one or a few checks exist. But when you want to automate a procedure so that you can handle thousands of checks quickly—and when you want a procedure you can use and modify over a long period of time—COBOL is one of the best tools available. □

COBOL Books

There are any number of good books that will help the beginner learn COBOL. Because the language has traditionally been run on mainframe computers, though, very few of these deal specifically with microcomputer COBOL. The distinction is important, especially given the interactive capabilities of microcomputers.

Among the many general COBOL texts are:

Ashley, Ruth. *ANS COBOL.* New York: John Wiley and Sons, 1979.

Shelly, Gary B. and Cashman, Thomas J. *Introduction to Computer Programming Structured COBOL.* Fullerton, CA: Anaheim Publishing Co., 1977.

Stern, Nancy and Stern, Robert A. *Structured COBOL Programming,* 2nd ed. New York: John Wiley and Sons, 1980.

A useful reference for microcomputer implementations of COBOL is:

Grauer, Robert. *TRS-80 COBOL.* Englewood Cliffs, NJ: Prentice-Hall, 1983. While specifically for Radio Shack COBOL, the information presented in this book is pertinent to other environments as well.

develop new software for every new machine, and they hoped to achieve the software portability they were looking for by defining a standard COBOL. If all manufacturers incorporated these standards into the COBOL compilers they built, then the same programs would run on *any* of those compilers with only very minor changes.

A noble idea, but it hasn't worked out as well as intended. Though COBOL's features are clearly defined by the American National Standards Institute (ANSI), there are many different gradations in the standards as well as many ways of implementing them. Consequently, it's very possible to own a COBOL compiler that conforms to ANSI standards but won't compile code created by another standard compiler.

This is to say that all COBOLs are not created equal, especially when it comes to microcomputer versions. As you might imagine, a COBOL compiler complete with all features takes up a lot of machine memory—much more than can be afforded by microcomputers or even small minicomputers. What it boils down to is that microcomputer COBOLs don't have all the features of their mainframe progenitors. Compiler technology and specific features vary from one company's implementation to another. If you're interested in serious COBOL programming, you must do some comparison shopping. Check carefully to determine what you're getting for your money. Make sure you have the features typically needed in business computing.

Disadvantages and Weaknesses

Now a word about the criticisms. Some say that COBOL programs are occasionally not understandable. When this is true, the programmer simply hasn't taken advantage of the language's capabilities. No language forces you to be a good programmer.

The most common complaint is that COBOL is wordy and repetitive. True—but that's the source of one of its strengths, as I have mentioned. Coding long data names and defining detailed file records are no doubt tedious activities (although more sophisticated COBOL generators may relieve some of the tedium), but these efforts will pay for themselves in the long run.

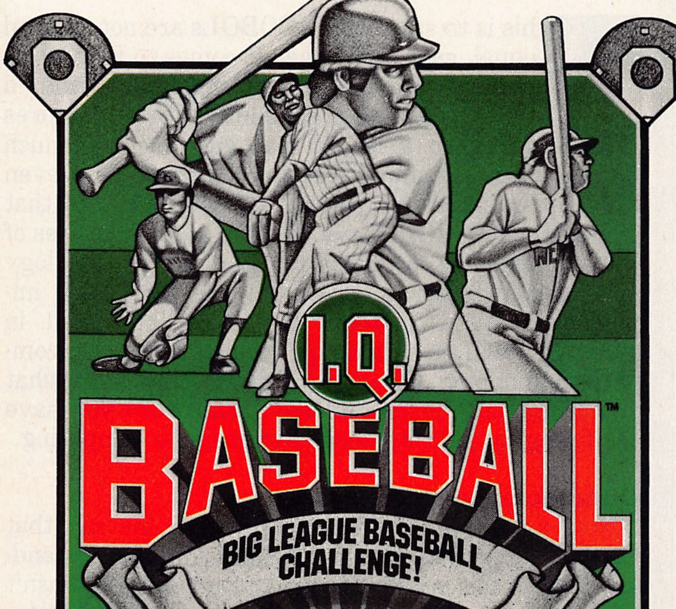
The complaint about COBOL's wordiness illustrates that in many ways COBOL is less a programmer's language than a business language. It was designed to serve business needs (which, as we've seen, it does exceedingly well) rather than to make program development convenient for programmers. Anyone who thinks it should be otherwise probably isn't a businessperson.

The proliferation of microcomputers has helped foster the notion that programming is a private activity. In many cases, the owner functions as systems analyst, programmer, end user, and business manager all in one. Programming is something he does for himself and by himself.

Nothing could be further from true business programming, in which the needs and pleasures of the programmer are subservient to any number of other concerns. But as microcomputers have become more powerful and consequently more capable of handling COBOL compilers, they have found a place in business programming. In effect, this means that they are becoming powerful enough to meet the needs served in the past by mainframes.

Another weakness ascribed to COBOL is that it doesn't lend itself to short, quick programs. True again, but that's not what it was designed for. Nor was it intended to handle the complex, intensive computations usually involved in scientific applications. COBOL will, however, do a better job with the straightforward arithmetic functions needed by business than most number-crunching compilers will. Because it doesn't have to handle the enormous range of numbers science demands, it is better able to make sure your every penny is accounted for.

COBOL is a highly specialized language. It was not designed to be a general-purpose language that will let you do a bit of everything. Precisely because of these limitations, it succeeds as an extremely useful business programming language—one clearly worth learning for any would-be programmer. □



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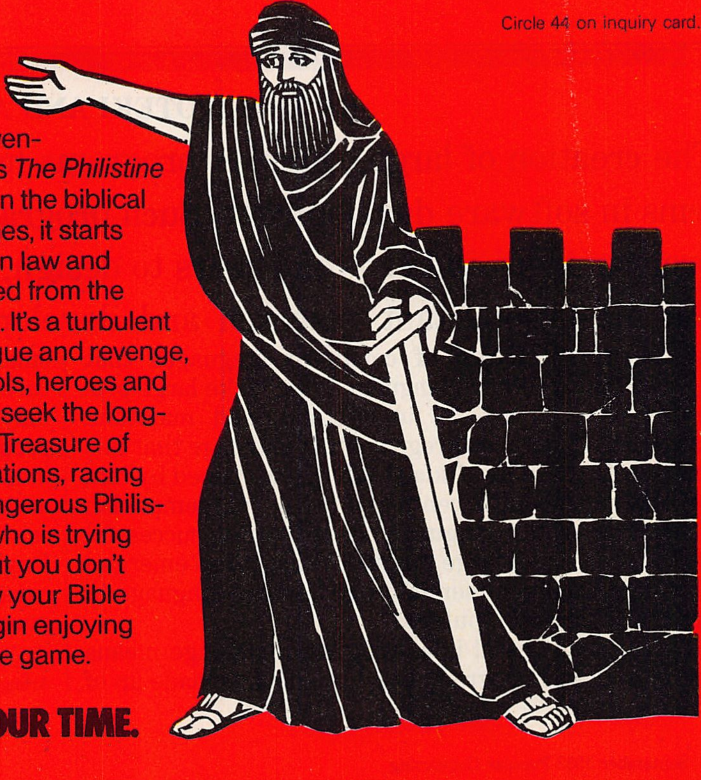

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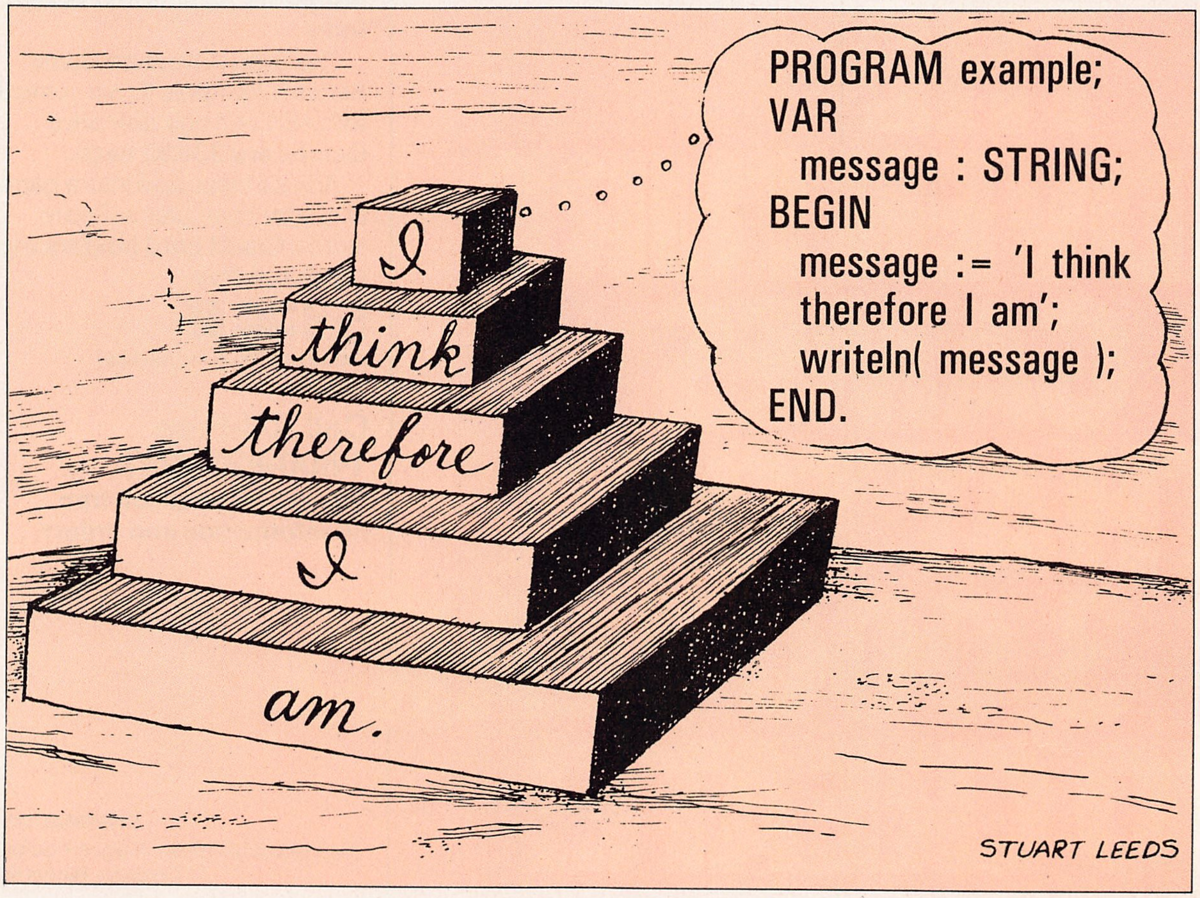

```
PROGRAM example;
VAR
  message : STRING;
BEGIN
  message := 'I think
  therefore I am';
  writeln( message );
END.
```

BY TOM WOTEKI AND ALAN FREIDEN

The creation of large, complex programs has long been one of the major problems in software development. Such programs may require the efforts of many programmers and can take years to design, implement, test, and debug. One of the most important research and development efforts in computer science has been the design of computer languages that alleviate this problem, languages that make large programs easy to create, understand, and maintain. Pascal is a structured programming language that fills this bill. Created by Niklaus Wirth and named by him for the seventeenth century French mathematician Blaise Pascal, this language has proved so successful for the creation of large programs that it has emerged as a significant commercial programming language in the era of microcomputers.

To say that Pascal is a structured language means that any Pascal program, large or small, is made up of smaller subprograms, each of which is itself a structured program. Because variables and subprograms may be named with a high degree of flexibility, Pascal programs are easy to read. Because Pascal variables must be specified according to type at the beginning of each program or subprogram, many potential errors can be avoided before a program is tested. Finally, Pascal's large variety of data types, together with its capability for defining new data types, makes the language suitable for a wide range of applications.

Tom Woteki and Alan Freiden are principals of Information Systems Inc., an Arlington, Virginia, software development firm.

Illustration by Stuart Leeds

Two characteristics of Pascal sometimes surprise programmers brought up on BASIC. The first is that, as we've already mentioned, all variables and their types must be declared in a special section at the beginning of a program. In fact, each programmer-defined symbol and how it might be used must be explicitly declared. This is a major reason why Pascal programs tend to be free of errors and easy to modify.

> A structured program is one that is made up of smaller subprograms, each of which is itself a structured program.

The other characteristic is that Pascal is compiled rather than interactively interpreted. Because BASIC offers immediate response to what is typed in at the keyboard, program preparation is not separated from testing and execution. In Pascal, however, a text editor is used in program preparation. In a distinct second step, the prepared text, or *source* program, is submitted to a Pascal compiler, a program that translates source code into *object* code that the computer can directly execute. Any changes to the source code require the programmer to go back and recompile the entire program. One major advantage of separating the programming process into these steps is that Pascal programs, once they are compiled, run much faster than comparable BASIC programs that have been interpreted rather than compiled.

A Pascal program consists of three major sections: the *header*, the *declaration* section, and the *body*, as illustrated by this elementary program:

```
PROGRAM example;
VAR
  message : STRING;
BEGIN
  message := 'Hello';
  writeln ( message );
END.
```

The header consists of the keyword PROGRAM and the name of the program ("example" in this case). The declaration section is a listing of the variables, data, and subprograms used in the program. Only one variable is declared in our example—this is the string we are calling message. The body of the program is made up of statements, as commands are known in Pascal. The statements in the body of our sample program give the value 'Hello' to the variable and display it on the video screen.

Data Types

The philosophy of Pascal assumes that good programming methodology requires a rich variety of data types and data-structuring facilities that allow the programmer to combine different primitive data objects to form new, higher-level ones.

Pascal offers all of the simple data types commonly found in other languages: *Boolean* (or logical in FORTRAN), *character*, *integer*, and *real*. Pascal's Boolean logic does not include bit manipulations. The original Pascal did not include strings, but because strings are now found in all microcomputer versions that we know of, we may as well say that strings are also standard. In addition to these common types, Pascal includes *sets* (structured collections of data objects), *records* (hierarchical data structures), *arrays* (tables of identical kinds of data objects), *pointers* (indirect references to data), *files* (external aggregates of records), and *programmer-defined* data types.

The Pascal programmer's ability to define data types is an especially interesting and powerful feature of the language. Let's look at an illustration of this capability. The command

```
TYPE
  color = ( red, yellow, blue );
```

defines the data type "color" that can then be given to variables, as in this command:

```
VAR
  brush : color;
```

This declares a variable named brush whose permissible values are the symbols red, yellow, and blue. The statement

```
  brush := red;
```

assigns brush the value red. We could even go on to write subprograms to mix colors.

The set is a data type that allows us to define variables whose values are collections of other values. Just as a key ring (the set) serves to collect keys (the values collected), so we may define a variable called palette, as in this command:

```
VAR
  palette : SET OF color;
```

Pascal Books

Barnard, David, and Crawford, Robert. *Pascal Programming Problems & Applications.* Reston, VA: Reston Publishing Co., 1982.

Borgerson, Mark J. *A BASIC Programmer's Guide to Pascal.* New York: John Wiley and Sons, 1982. An introduction for BASIC programmers.

Clark, R., and Koehler, S. *A UCSD Pascal Handbook.* Englewood Cliffs, NJ: Prentice-Hall, 1982. An excellent reference for UCSD Pascal.

Findlay, William, and Watt, David A. *Pascal: An Introduction to Methodical Programming.* Washington: Computer Science Press, 1978.

Grogono, Peter. *Programming in Pascal.* Reading, MA: Addison-Wesley, 1980.

Luehrmann, Arthur, and Peckham, Herbert. *Apple-Pascal: A Hands-on Approach.* New York: McGraw-Hill, 1981.

Wirth, Niklaus. *Algorithms Plus Data Structures Equals Programs.* Englewood Cliffs, NJ: Prentice-Hall, 1976. A standard technical reference by the author of Pascal.

This assigns the variable values that are collections of colors. We may have sets of characters, sets of integers, or, as in our example, sets of programmer-defined types.

Records embody another powerful data-structuring concept and are well suited to certain kinds of information. Defining a record enables a programmer to group logically related information into a single data unit. The record may be manipulated as a unit, or individual entries in the record (called *fields*) may be manipulated separately, as we see in this example:

```
TYPE
  check = RECORD
             number    : INTEGER;
             date      : RECORD
                            month,
                            day,
                            year : INTEGER;
                            END;
             payee     : STRING;
             amount    : REAL;
             memo      : STRING;
             signature : STRING;
             END;
```

Here we declare a data type called check consisting of the fields number, date (which itself is a record), payee, and so forth. The END statement marks the completion of the record definition.

We could now declare variables of the type check that could be manipulated as blocks or field by field. For example, we might store some checks in a file (treating the checks as units), or we might tally the amounts for several checks (which would require access to individual fields). Note how closely this corresponds to what we do when we balance our checkbooks: we store entire checks, but we access individual items on the check when we balance our books. Records may also be defined in COBOL and PL/I, but they are most flexible in Pascal.

This brings us to files, which are used for external storage. Files can hold any type of data, but they're most often used to store text or records of some type.

Pascal arrays are more effective than those used in other programming languages. They may be made up of any data type, including sets, records, and programmer-defined types as well as the more typical integers and reals. Conversely, a record may include arrays in its fields. Together, arrays and records are powerful tools for describing data. The essence of this power is the ability to describe in a word a data object that is meaningful to both humans and computers.

Pointers are used to link data structures when the relationships among the data are too complex to be represented by arrays or when those relationships change during execution. For example, you must specify in advance how many data objects will be included in an array, but if you don't know how many items you will need, you can use pointers to create the necessary space as the program is used.

Control Structures

Pascal's richness of data types is complemented by a wide variety of control structures used to direct a program's order of execution. Programs are made up of aggregates of subprograms that, as with data objects, may be referred to by meaningful names.

These control structures are designed to facilitate the development of structured, modular programs in which relatively complex tasks are broken into smaller, simpler, clearly defined subtasks or *modules*. Programs structured in this way are more likely to run correctly the first time, but even if they don't, they're easier to modify and correct.

The most important thing to understand about Pascal's control structures is that each block of code should have a clear point of entry and only one exit. You don't jump around arbitrarily from place to place (as you might do with GOTO commands in a language such as BASIC).

Pascal includes a REPEAT-UNTIL control structure that repeats a set of statements until a certain condition is satisfied as well as a WHILE-DO structure that repeats a set of statements while a particular condition continues to be true. IF-THEN-ELSE is Pascal's simplest conditional statement, with the more complex CASE statement being equivalent to a nested series of such conditionals. A CASE unit has only one point of entry, but there may be several possible exits allowing for the particular conditions when the program is executed. Pascal also offers a FOR-DO statement similar to BASIC's FOR-NEXT loop as well as a form of GOTO, but the latter is rarely used and never recommended.

Block Structure and Procedures

Block structuring is a programming concept that allows related declarations and statements to be grouped together into *blocks*. Properly used, block structure makes a large, complex program easy to understand. Block structure also allows explicit control over both allocation of storage for variables and access to variables from other parts of a program.

Block structure in Pascal rests on the concept of *procedures*. Procedures are blocks that are given names and invoked by name from another part of the program. They are very much like programs in that they comprise a header consisting of the keyword PROCEDURE and the name of the procedure, a declaration section, and a body.

The variables defined in a procedure are *local* variables that are used only while a particular procedure is being executed. Procedures are nested within programs and may also be nested within each other—further increasing the modular structure of the program. Because procedures are clearly referred to by their names, they are useful in representing logically distinct operations.

Procedures may also contain *parameters* that apply the same formula or action to a variety of specific inputs and produce different outcomes. A procedure with parameters is like a recipe—while the amounts of ingredients may vary (as may a procedure's inputs), the directions on what to do with those ingredients remain the same.

Closely related to procedures are Pascal *functions*. Like its mathematical counterpart, a function returns a value whenever its name appears in a program. The uses of procedures, functions, and data declarations are illustrated in the sample program on page 102.

Weaknesses

From its inception Pascal was designed to be a portable language. While such portability means independence from hardware, it also means that Pascal by itself is not well suited to accessing special features of its host computer. Most microcomputer versions of the language allow the programmer to overcome this, usually by integrating assembly-language routines. In such cases the programmer must exit Pascal.

Standard Pascal does not allow dynamic arrays that can change in size according to need. When you declare an array variable, you have to decide how many elements it will have. If you underestimate, your program will be in trouble when it runs, but if you overestimate, you'll be reserving (and wasting) a lot of memory that could be used for other purposes. Dynamic arrays are included in several microcomputer versions of Pascal, however, and a proposed international Pascal standard also includes them, so this limitation may soon disappear.

Why Learn Pascal?

From the point of view of many potential users, Pascal's major drawback is that it is a compiled rather than an interpreted language. This means that developing and testing a small Pascal program can take a lot longer and involve many more steps than it would with an interpreted language like BASIC. Most

Pascal for Microcomputers

- Apple Computer Inc. (20525 Mariani Ave., Cupertino, CA 95014) markets Apple Pascal 1.1, a Pascal operating system for the Apple II (with Apple Language card or similar 16K-byte RAM card) and the Apple IIe. Based on UCSD Pascal version II.0, the system sells for $250 and requires no additional software.
- Digital Research Inc. (POB 579, Pacific Grove, CA 93950) sells two versions of its Pascal MT+ compiler. The $350 version runs under CP/M 2.2, while the version for CP/M-86 retails at $600.
- JRT Systems (45 Camino Alto, Mill Valley, CA 94941) offers a Pascal compiler for CP/M systems that sells for $29.95.
- Microsoft Corp. (10700 Northup Way, Bellevue, WA 98004) sells a $500 Pascal compiler for the MS-DOS operating system.
- Network Consulting Inc. (Discovery Park, Suite 110, 3700 Gilmore Way, Burnaby, B.C., Canada V5G 4M1) sells a full UCSD p-System for the IBM Personal Computer and PC XT. The $845 system is an implementation of Softech Microsystems' UCSD p-System version IV.1.
- Softech Microsystems Inc. (16885 West Bernardo Dr., San Diego, CA 92127) markets a full UCSD p-System for a variety of computers.

programs written by users of personal computers are small ones designed for quick solutions to particular problems, and the use of Pascal for such programs may be a form of overkill.

Ironically, the characteristics of Pascal that make it relatively unsuited for small programs are a direct consequence of its strengths as a programming language. The discipline imposed by the language makes it easier to understand large programs, but it may be more than a small program demands. For serious development of large programs or for the creation of tools that will be used over and over again (and require modifications from time to time), Pascal is clearly superior.

Experts generally consider Pascal an important language for people who are planning to study computer science or to learn programming. Indeed, the College Entrance Examination Board has recently designated Pascal as the required language for advanced-placement courses in computer science for high school students (see "The Push for Standardization" on page 65). While it is true that an experienced programmer can write clearly structured programs in any language, learning the principles of structured programming is much easier in Pascal.

> Pascal's control structures facilitate the development of programs that are likely to run correctly the first time through; if not, they'll still be easier to correct or modify.

Is Pascal difficult to learn? We don't think so, but the question is relative and may depend on which language you learn first. Programmers become accustomed to the first language they learn, making it the standard by which all others are judged. Even the poor features of the familiar language come to be seen as necessities, and a new language seems inferior. Don't let such subjective evaluations bar your way to learning Pascal, a powerful and elegant programming language. □

Sample Pascal Program

This Pascal program asks a user for two numbers, prints the sum of those numbers, and asks whether the job is done. If the user types Y, the process stops. Otherwise, the REPEAT-UNTIL loop repeats the entire process. Each part of the process uses a separate procedure or function, as shown in the body of the main program printed at the *bottom* of the listing. At the *top* of the listing are the program name and the variable declaration. Between the two are the procedure and function definitions, each with its own heading, declaration, and body.

```
PROGRAM add_numbers_till_done;
VAR
  a, b, t :REAL;

  PROCEDURE get_a_number( VAR x : REAL );
  BEGIN
    write ('Enter a number: ');
    readln ( x );
  END;

  PROCEDURE do_total ( x, y : REAL; VAR sum : REAL );
  BEGIN
    sum := x + y;
  END;

PROCEDURE report_total ( z : REAL );
BEGIN
  writeln ( 'TOTAL= ', z );
END;

FUNCTION done : BOOLEAN;
VAR
  ch : CHAR;
BEGIN
  write( 'Done? ' );
  read( ch );
  writeln;
  IF ( ch IN ['Y', 'y'] ) THEN done := TRUE
  ELSE done := FALSE;
END;

BEGIN
  REPEAT
   get_a_number ( a );
   get_a_number ( b );
   do_total ( a, b, t );
   report_total ( t );
  UNTIL done;
END.
```

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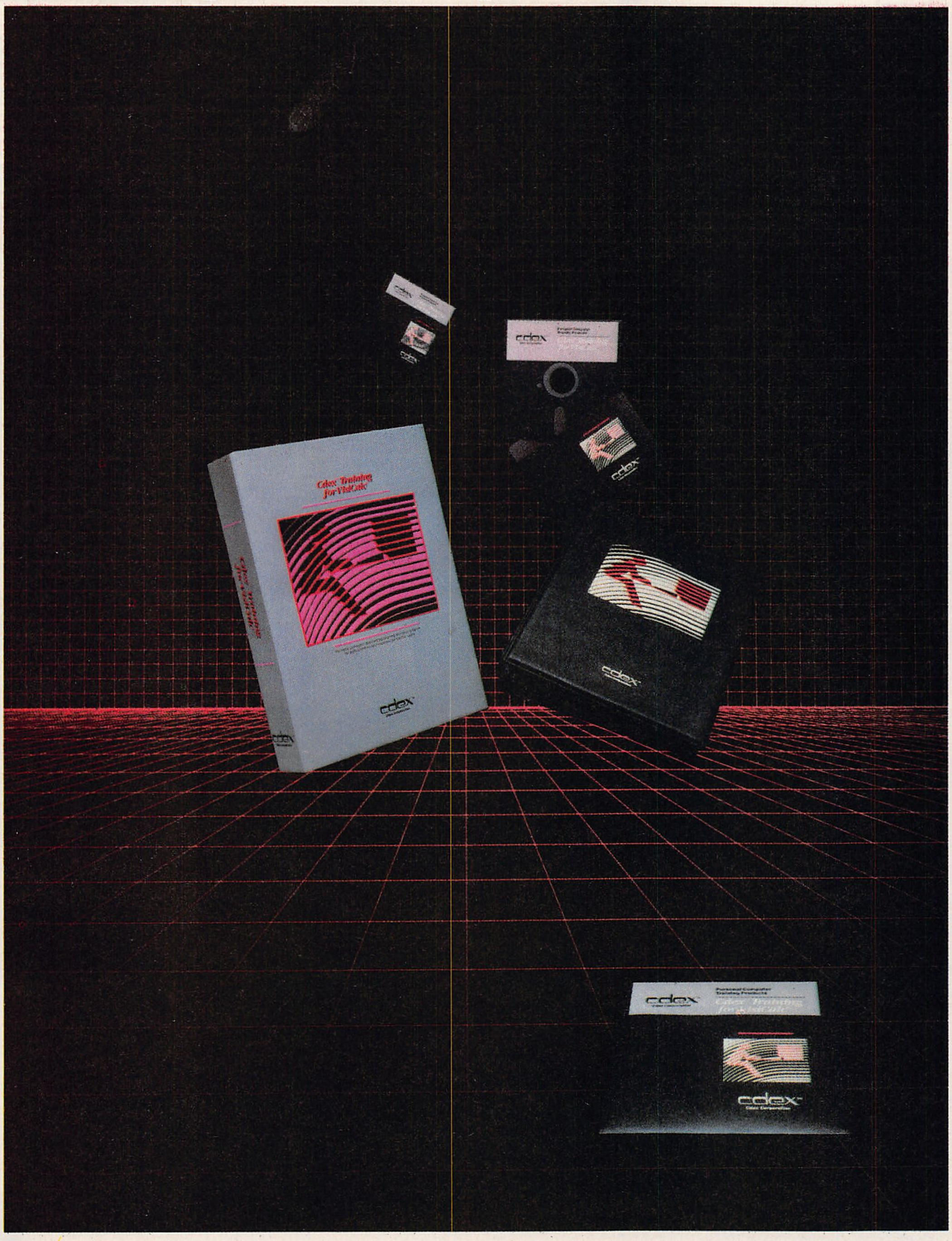

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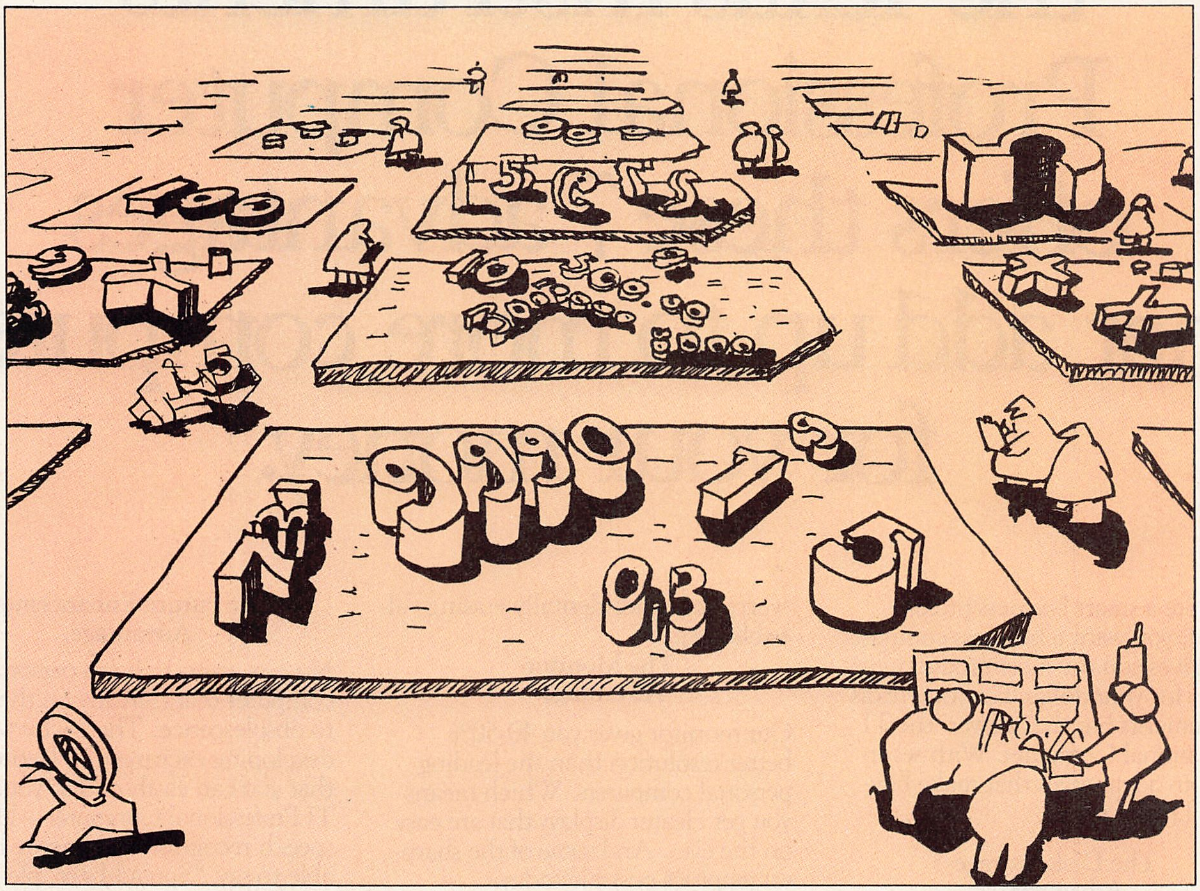
FORTRAN

The first computer language is still popular for scientific programming



BY MEL KANNER

FORTRAN—the name itself sounded like something out of science fiction when the language was first introduced in the mid-1950s. FORTRAN became the first widely used computer language, and its name (short for FORmula TRANslator) was the first example of what is now known as "computerese." It set the trend for those acronyms and compound words that seem to be taking over the language.

As a computer language, FORTRAN has had a remarkable influence as well as incredible staying power. In a world where everything else is changing overnight, FORTRAN's basic form and style have changed very little in almost 30 years, although the language has acquired new features and capabilities. It has been standardized twice, in 1966 and 1977, and we may expect to see another standard established during the 1980s. In addition to its own popularity as a programming language, FORTRAN inspired BASIC, the most popular computer language ever, which is essentially a streamlined and simplified version of FORTRAN.

Although it may be used as a general-purpose programming language, FORTRAN's forte is scientific and engineering applications, and it is in this area that it is still widely used today. Its special capabilities for number crunching, together with the thousands of mathematical subroutines that have been developed in FORTRAN, are primarily responsible for its con-

---

Mel Kanner is chief programmer for Microsoft's FORTRAN 77 compiler and serves on the ANSI/IEEE Pascal standards committee.

Illustration by Maciek Albrect

In a world where everything else is changing overnight, FORTRAN's basic form and style have changed very little in the almost 30 years it's been in use.

tinued use. The many existing FORTRAN programs that can be used and adapted for every conceivable scientific or technical purpose mean that the language is unlikely to become obsolete. No matter how elegant and efficient new languages become, FORTRAN is still popular.

FORTRAN has provisions for standard programming constructs such as looping, branching, subroutines, functions, and assignment of values to variable names. It supports a limited number of data types: integer, single- and double-precision floating-point (real) numbers, complex numbers, logical (Boolean) expressions, and strings. The only structure available for organizing data is the array. Variables in FORTRAN may have names of up to six characters, beginning with a letter. Unless otherwise specified, all variable names beginning with the letters I through N represent integers.

A FORTRAN program, subroutine, or function definition consists of a *header statement* in which the program is named, a series of *specification statements* in which data types may be specified and array dimensions declared, and finally a list of *executable statements* that constitute the body of the program. In the sample program on page 109 that calculates means of real numbers, the subroutine is given first, followed by the program that calls it.

FORTRAN for Microcomputers

The following FORTRAN implementations are currently available:

- A FORTRAN compiler for the IBM Personal Computer with MS-DOS is marketed by Microsoft Consumer Products, 10700 Northup Way, Bellevue, WA 98004.
- FORTRAN-80 for the Apple II, TRS-80 Model II, and other Z80-based computers with the CP/M operating system is also a product of Microsoft (see address above).
- A FORTRAN 77 compiler for the UCSD p-System is available from Softech Microsystems, 16885 West Bernardo Dr., San Diego, CA 92127.
- SSS FORTRAN for the CP/M operating system is sold by Supersoft Associates, POB 1628, Champaign, IL 61820.

FORTRAN programs are written in a rigid format that dates back to the days when programs were entered statement by statement on 80-column punch cards. For example, the first five spaces are reserved for labels (line numbers). A character in the sixth column means that a statement is continued from the line above, and actual program statements must be printed in columns 7 through 72. Blanks are ignored—AB CD is interpreted as the variable name ABCD. The letter C or an asterisk in column 1 is the equivalent of REM in BASIC, indicating a comment to be ignored by the compiler.

Unlike BASIC, line numbers in FORTRAN programs are used only where necessary to control loops, conditionals, or GOTOs. Situations demanding line numbers are shown in these typical programming statements:

```
      DO 150 I = 1,20
           .
           .
150   CONTINUE
      GOTO 200
200   IF (A) 10,20,30
```

FORTRAN's arithmetic IF statement branches to the first line number if the value of A is negative, to the second if it's zero, or to the third if it's positive. FORTRAN also allows for a logical IF statement that executes a command based on the (true or false) value of a logical expression.

Like its program definitions, FORTRAN's input and output statements require a specific format for reading, writing, and printing data. Subroutines may be called from within a program or from another subroutine using the CALL statement, as in CALL XYZ. Functions that return values can be used directly within an algebraic expression, such as the function F(C) in the expression (A + B * F(C)).

Strengths of the Language

One of FORTRAN's strengths for scientific and technical programming is that its algebraic formulas are written in almost the same form as conventional mathematical expressions. In addition, exponentiation and transcendental functions are either built into the language or provided via standard library routines. Furthermore, a huge library of mathematical functions and routines for performing all kinds of statistical calculations or finding numerical solutions to differential equations is readily available to any FORTRAN programmer.

A huge library of mathematical functions and routines is readily available to any FORTRAN programmer.

FORTRAN's modular structure encourages the creation of these reusable library routines. Each subroutine or function can be compiled and tested separately then added to the ever-growing library.

In fact, FORTRAN's major strength lies in its widespread use and in the extensive sharing among programmers of techniques and information. The language has been implemented on almost every mainframe and minicomputer, and, because many scientific and technical programmers prefer the language, it will soon be available on many microcomputers.

Weaknesses

Like the QWERTY typewriter keyboard, FORTRAN perpetuates itself through its continued use and its extensive established base of useful library functions. Some would say that this is unfortunate because FORTRAN admittedly has some major weaknesses. They would prefer that FORTRAN just wither away and that people switch to more elegant languages in which the problems of FORTRAN have been corrected.

FORTRAN's primary weakness is that it is very easy to make a typographical error and end up with a perfectly "legal" program that produces incorrect results. This can occur because blanks are ignored and because a statement's type is determined from its context rather than from keywords. For example, DO 150 I = 1,10 is the start of a loop varying the index I from a starting value of 1 to an ending value of 10. If you inadvertently wrote DO 150 I = 1.10, with a period between the 1 and 10 instead of a comma, your statement would be interpreted as an assignment of the value 1.10 to the variable DO150I. Obviously, it could take hours to trace this bug. The automatic categorization of variables by the first letters of their names can also cause errors. If you wrote IXXI instead of IXX1 you'd have a new variable.

FORTRAN has other irritating weaknesses, but at least they don't lead to long debugging sessions. For example, the language is column-oriented, but because most program development today is done with text editors on video terminals instead of with 80-column punch cards, attention to column alignment seems an unnecessary distraction. Also, FORTRAN programs tend to have a somewhat cryptic quality because the language permits only six-character names for programs and variables. Inventing meaningful names within this constraint can be quite challenging.

Impressions

FORTRAN is not a difficult language to learn or use, but mastery of all its features can take quite some time. Effective use of FORTRAN's file-handling routines or format descriptors may take months to develop. Because FORTRAN is not an interactive language like BASIC, the programming process lends itself to careful planning on paper. Each step in the development requires editing, compiling, linking, and running the program.

The new features added to the 1977 standard permit FORTRAN programs to be structured. However, because most FORTRAN programmers were trained in the style of the 1966 standard, a large number of today's commercial FORTRAN programs are not structured, making them difficult to read and understand.

FORTRAN is a large language, and full support requires a large compiler. Until recently most microcomputers didn't have enough memory to support the compiler and the

FORTRAN Books

Agelhoff, R., and Mojena, Richard. *Applied FORTRAN 77 Featuring Structured Programming*. Belmont, CA: Wadsworth, 1981.

Davis, Gordon B., and Hoffman, Thomas R. *FORTRAN: A Structured, Disciplined Approach*. New York: McGraw-Hill, 1978.

Friedman, F., and Koffman, E. *Problem Solving and Structured Programming in FORTRAN*. Reading, MA: Addison-Wesley, 1981.

Wagener, J. L. *Principles of FORTRAN 77 Programming*. New York: John Wiley and Sons, 1980.

large programs from the available libraries. But this situation is rapidly changing as memory gets less expensive. It is now practical to configure systems with a minimum of 128K bytes of memory. Also, newly available computer chips facilitate the use of FORTRAN on microcomputers. For example, Intel's 8087 numeric data processor, which is used in the IBM Personal Computer, gives to microcomputers the number-crunching capability that had previously been available only on larger computers.

As much as some would like to see FORTRAN fade away, its future seems assured by its large library of scientific and mathematical functions. Far from abandoning the language, many FORTRAN programmers are demanding that it be supported on the personal computers now available to them. □

Sample FORTRAN Program

```
      SUBROUTINE RMean (A, NumelA, Mean)
C
C  Compute the mean of real numbers. The numbers are
C  passed in the array A. The number of elements in A is
C  passed in as NumelA. The computed mean is returned in the
C  argument Mean.
C
      INTEGER NumelA
      REAL A(NumelA), Mean
C
C
      Sum= 0.0
C
      DO 100  I = 1, NumelA
         SUM = Sum + A(I)
100   CONTINUE
C
      Mean = Sum / NumelA
      END
C
C
C
      PROGRAM Test
      DIMENSION Ra (5)
C
      Ra (1) = 1.0
      Ra (2) = 2.0
      Ra (3) = 3.0
      Ra (4) = 4.0
      Ra (5) = 5.0
C
      CALL Rmean (Ra, 5, Answer)
      WRITE (*, 20) Answer
20    FORMAT (' The mean is: ', F5.2)
      END
```

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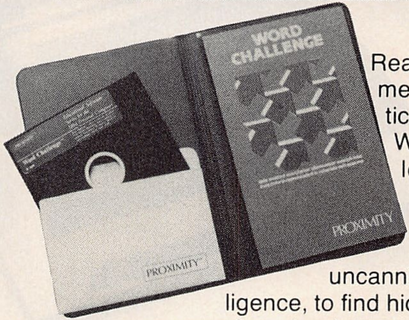

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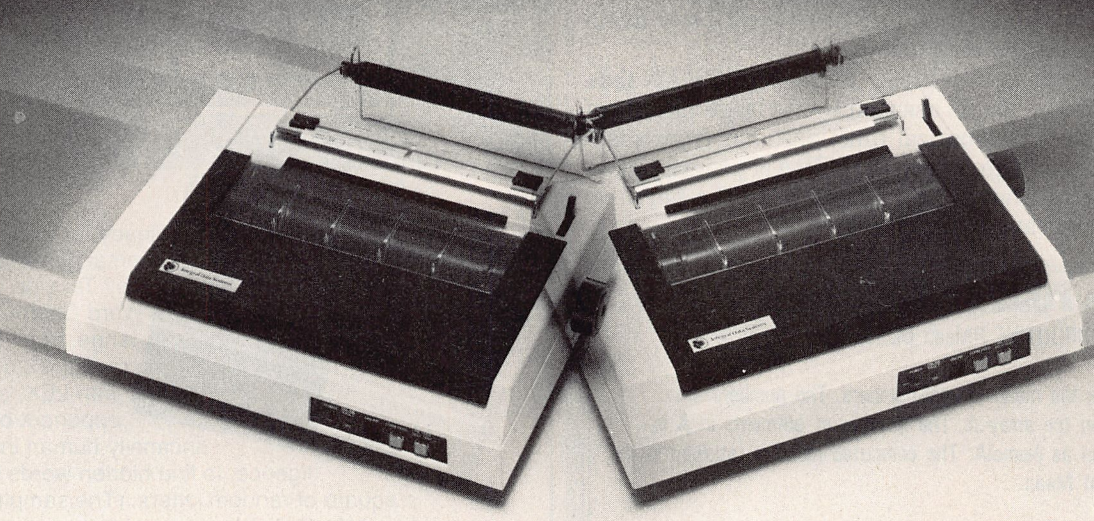

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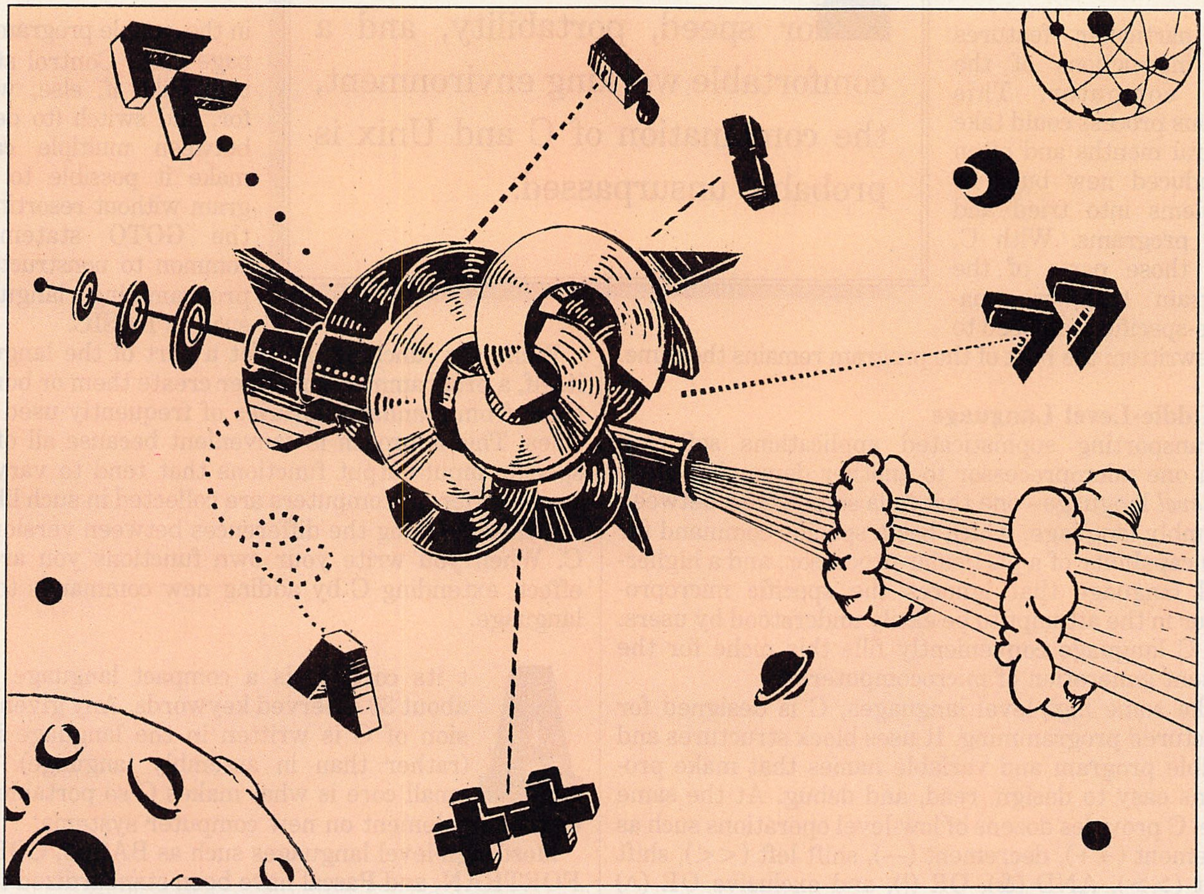
C

The language designed for applications development and portability



BY BRUCE ROBERTS

C is a powerful programming language that's currently attracting lots of attention in the computer software industry. Leading firms such as Visicorp, Microsoft, and Digital Research are using C in major development projects, and Hollywood has found the language to be the ticket for creating the striking graphics and special effects seen in films such as *Star Trek II* and *Return of the Jedi*.

Systems programmers are the primary users of C. Often referred to as a "portable assembly language," C makes it easy to transfer programs between computers with different processors while still facilitating the use of the specific features of particular machines and producing fast, efficient programs. Because of the fierce competition to get new applications on the market quickly, this sort of versatility is crucial in today's microcomputer industry, especially in developing software for the newer 16-bit computers, an effort which requires that a program be readily adaptable to any of the four or five leading microprocessors.

Originally, popular microcomputer programs like Visicalc, Microsoft BASIC, Wordstar, and the CP/M operating system were written in assembly language for a specific 8-bit processor. This approach limited each program to the hundred or so instructions available to that processor. Moving an assembly-language program to a computer based on a different processor required translating or rewriting all of the code to use

---

Bruce Roberts is a technical editor for BYTE magazine.

Illustration by Terry Allen

For speed, portability, and a comfortable working environment, the combination of C and Unix is probably unsurpassed.

the particular features and instructions of the new computer. This tedious process could take several months and often introduced new bugs or problems into tried and true programs. With C, only those parts of the program that use machine-specific code need to be rewritten; the bulk of the program remains the same.

A Middle-Level Language

Transporting sophisticated applications software from one microprocessor to another demands a *middle-level* language—one that falls somewhere between assembly language, which has a specific command for each capability of a particular processor, and a higher-level language that ignores the specific microprocessor in the attempt to be easily understood by users. The C language conveniently fills this niche for the present generation of microcomputers.

Like some high-level languages, C is designed for structured programming. It uses block structures and flexible program and variable names that make programs easy to design, read, and debug. At the same time, C provides dozens of low-level operations such as increment (++), decrement (--), shift left (<<), shift right (>>), AND (&), OR (|), and exclusive OR (∧) that correspond exactly to the machine-language operations of various microprocessors. Using such commands, one line of C code can replace several lines of machine code. This mix of capabilities means that large programs written in C—operating systems and computer languages, for example—can be transported to new computers with 80 percent or more of the original code unchanged. Furthermore, a well-designed C program can run almost as rapidly as the same program would if translated into assembly language. Finally, the structured nature of the language makes the few necessary changes easy to implement and test.

C also shares several other characteristics with high-level languages. It is easier to learn than assembly language, makes for faster programming, has a standard syntax independent of a specific computer or microprocessor, yields portable programs, uses a standard subroutine library, and has support programs for a comfortable working environment.

C promotes well-structured programs written in a style similar to Pascal's, with the main body of the program kept short and the different building blocks or functions of the program called by name (as illustrated in the sample programs on page 114). Control structures like if, else, while, for, and switch (to decide between multiple cases) make it possible to program without resorting to the GOTO statements common to nonstructured programming languages such as BASIC.

While C's functions are not a part of the language itself, a programmer can either create them or borrow them from standard libraries of frequently used routines. This approach is convenient because all of the specific input/output functions that tend to vary between different computers are collected in such libraries, thus isolating the differences between versions of C. When you write your own functions you are, in effect, extending C by adding new commands to the language.

At its core, C is a compact language with about 30 reserved keywords. Any given version of C is written in the language itself (rather than in assembly language). This small core is what makes C so portable and easy to implement on new computer systems.

Most high-level languages such as BASIC, COBOL, FORTRAN, and Pascal have been standardized to ensure portability. However, implementing these large languages on new machines often takes much longer than it would with C because of their size and complexity as well as the fact that they are usually written in the assembly language of a particular host computer.

C is more relaxed in its rules than most high-level languages, generally letting you do anything that hasn't been specifically prohibited. The language seems to assume that you know what you're doing and does not hinder you. For example, individual bits of information can be manipulated, pointers allow you to access memory locations and their contents directly, and you can add or define new data structures if the current choices are too limiting. While such features can add considerable power and flexibility to C programs, they can also produce obscure errors that are hard to track down, thus making C a difficult language for beginning programmers. But as the language is primarily used by experienced professional programmers, such problems are not a real concern.

Like its name, programs written in C tend to be compact and somewhat cryptic to the uninitiated. In fact, a popular joke among programmers is that in C, the word "terse" is spelled "trs."

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C and Unix

Ever since C was created by systems programmer Dennis Ritchie at Bell Laboratories in 1972, it has been closely associated with the Unix operating system. Originally written for Digital Equipment Corporation's PDP-11 minicomputer, both C and Unix have since migrated to every type of machine from microcomputers to the ultrasophisticated Cray-1 supercomputer.

Unix was once found primarily in academic research settings, but it is now attracting a large following among computer professionals, many of whom first encountered C and Unix at colleges and universities. Because it was created for a sophisticated timesharing environment, Unix has proved flexible and powerful enough to meet the needs of professional programmers working with the newest generation of microcomputers. Unix supports hierarchical file structures,

Sample C programs

An example of a C program that prints a short message is the following:

```
/* This program prints "hello, world" */

main( )
{
    printf("hello, world \n");
}
```

The equivalent BASIC program would look like:

```
10 REM This program prints "hello, world"
20 PRINT "hello, world"
```

Comments in C are enclosed with /* and */ to show the beginning and end of the comments area, which can extend over several lines. Usually a program will start with comments to define the program's name, use, and limitations. The main routine that a program will perform starts with the word main. This is a special function that must be found in any complete C program. Any values or *arguments* that are being given to the program at the outset are enclosed in parentheses.

The beginning and end of a group of statements are marked with braces. In the sample above, the first brace signifies the start of the statements that are the main program. A C program will always end with a closing brace.

The line between the braces does all the work in this short example. The printf (print formatted) library function is called by the program and given a copy of all the information in parentheses—a string of characters in this case. The \n at the end of the character string stands for a "new line" character, that is, a carriage return. Similarly, \t is a tab character, \b is a backspace, and \" is a double quotation mark. C does not take much for granted, and you often have to tell it exactly what characters you want to send where.

Like Pascal, each complete program statement ends with a semicolon, not just a line break. This means statements can be spread over several lines and indented to show the program's structure.

The printf function, not part of the small core of the C language itself, is one of over a hundred subroutines or *functions* (like Pascal's procedures) gathered into a standard library that is searched whenever a function named in the program is not defined in the program listing.

The following sample shows a longer C program with a function called in the main body of the program (greet) and defined and tested with nested if . . . else statements to see if the person running the program types y or n. Calls are also made to library functions, including getchar.

```
/* A sample C program showing nested if statements */

main( )
{
    int answer;

    greet( );
    answer = getchar( );
    if (answer == 'y')
        printf("Glad to hear it! \n");
    else if (answer == 'n')
        printf("Sorry to hear that. Hope it changes. \n");
    else
        printf("I don't understand %c. \n", answer);
}
greet( ) /* greet the computer user */
{
    printf("Do you like C so far? \ n");
    printf("Type y for yes, n for no, and press RETURN: ");
}
```

making it easy to differentiate among either the files of several different users or a range of different applications. Unix also supports *multiprocessing*, the simultaneous execution of different operations such as printing, editing, and sorting.

The critical connection is that Unix is written in C, lending the operating system easy portability to a variety of computers. This also means that Unix itself can be easily modified for specialized tasks or extended by adding new features. Unix shares C's *toolkit* philosophy in that it furnishes a collection of utility programs for such tasks as sorting, editing, and creating databases. It is this powerful environment that makes Unix especially suitable for large-scale project development. In terms of speed, portability, and a comfortable working environment, the combination of the C language and the Unix operating system is hard to beat.

Current trends illustrate the industry's appreciation of C and Unix. Microsoft, a leading microcomputer software development company, promotes Xenix, its own modification of Unix, and uses C and Xenix extensively for software development. The company's popular spreadsheet program Multiplan was written in C and became available almost immediately for many different microcomputers. In addition, Microsoft's office automation series called Multitools is being written entirely in C. Both Apple's Lisa and Radio Shack's Model 16 offer Xenix as a standard operating system. Microsoft also offers a version of the C language designed for the IBM Personal Computer and other computers using Intel's 8086/8088 microprocessors and Microsoft's MS-DOS operating system.

Digital Research, parent of the CP/M operating system, is also using C and Unix for software develop-

C Books

One of the best books on C is *The C Programming Language*, by Brian Kernighan and Dennis Ritchie (Englewood Cliffs, NJ: Prentice-Hall, 1978). This standard reference manual will serve as a complete introduction for experienced programmers, but novices lacking experience in other languages will find it tough going.

Reflecting C's increasing popularity, the number of other books on the language has grown in the last year to include:

Feuer, Alan. *The C Puzzle Book: Puzzles for the C Programming Language.* Englewood Cliffs, NJ: Prentice-Hall, 1982.

Hancock, Les, and Krieger, Morris. *The C Primer.* New York: McGraw-Hill, 1982.

Plum, Thomas. *Learning to Program in C.* Cardiff, NJ: Plum Hall Inc., 1983.

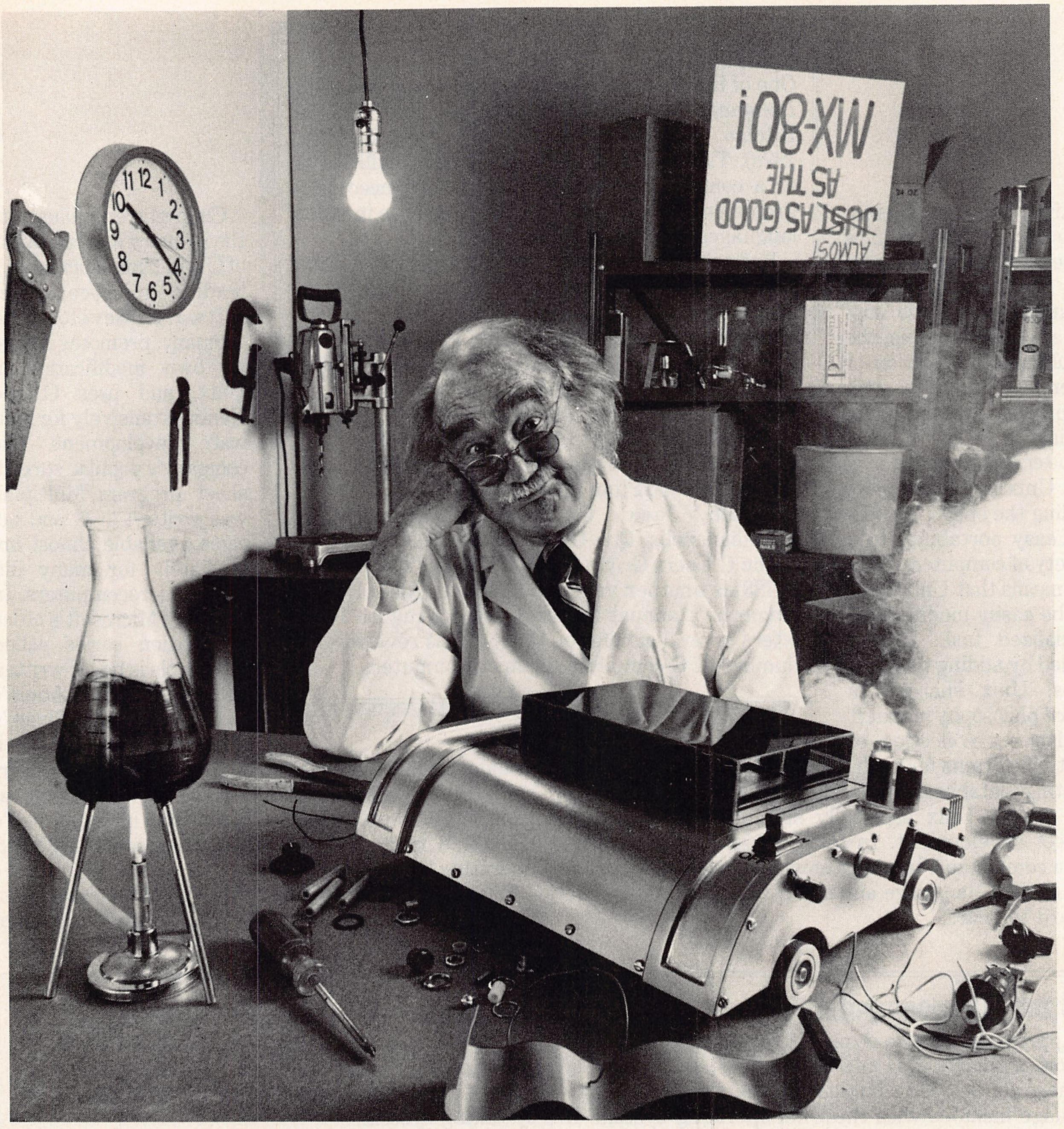
Purdum, Jack. *C Programming Guide.* Indianapolis: Que Corporation, 1983.

The C Users Group (POB 287, Yates Center, KS 66783) is another valuable resource. Also, BYTE magazine's annual language issue (August 1983) offers several articles on C as well as reviews of a number of C compilers for microcomputers.

C for Microcomputers

Approximately two dozen C language compilers are now available for microcomputers, but many of these do not fully implement the standard C language included with the Unix operating system. If you get a microcomputer with Unix, you will usually find a complete version of C included in the package. Among the most popular of the microcomputer C compilers are:

- Aztec C (from Manx Software Systems, POB 55, Shrewsbury, NJ 07701) is a full implementation of Unix C for Apple, CP/M, IBM, and Radio Shack personal computers.
- BDS C (from BD Software, POB 9, Brighton, MA 02135) was one of the first microcomputer versions of C for the CP/M operating system, which means that many public-domain C programs are written in this dialect. This version does not include floating point numbers, and its command names and input/output functions are not compatible with the standard Unix C.
- C/80 (from The Software Toolworks, Suite 1118, 15233 Ventura Blvd., Sherman Oaks, CA 91403) is an inexpensive subset of C that's well suited to trying out the language on computers with the CP/M operating system.
- Digital Research C (from Digital Research Inc., POB 579, Pacific Grove, CA 93950) is a full C compiler for the CP/M-86 operating system that promotes the portability of C programs between CP/M-86 and Unix.
- Microsoft C (from Microsoft Corp., 10700 Northup Way, Bellevue, WA 98004) is a repackaged enhancement of Lattice C, one of the most popular and complete C compilers for the IBM Personal Computer.
- Whitesmiths C (from Whitesmiths Ltd., 97 Lowell Rd., Concord, MA 01742) is the professional workhorse of the C compilers. It offers the full language with a very solid set of supporting utilities. Its standard input/output library was recently made compatible with Unix C.



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ment. The latest version of CP/M, developed for Motorola's 68000 microprocessor, is written in C. Digital Research also offers its own version of C, stressing its use as a bridge between Unix and CP/M.

Visicorp has also seen the programming on the wall and is writing its Visiword and Visi On packages in C. It is not uncommon for word-processing programs and operating systems to have well over 10,000 lines of instructions, and as programs get even larger and more sophisticated, C will become a natural choice for many high-volume consumer applications. C also lends itself to real-time control and input/output applications and is becoming popular with many industrial computer users.

C will not be all things to all people, however. Business programmers probably will not trade in their COBOL Cadillacs for C Corvettes, and accounting programs for general ledger and accounts receivable will probably still be written in COBOL or business BASIC. Also, FORTRAN is likely to remain the language of choice among scientists and engineers, although mathematicians may cast sidelong glances of envy at C's math functions.

> With C's mix of capabilities, large programs can be transported between different computers with 80 percent or more of the original code intact.

Standardization

One of the best things about C is that it was *not* designed by a committee; its consistency and simplicity strongly reflect this. Since its publication in 1978, Kernighan and Ritchie's *The C Programming Language* (see "C Books" on page 115) has helped to further standardize the language. But the true de facto standard for compilers is the current implementation

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C is a middle-level language—somewhere between assembly language specific for each microprocessor and high-level languages designed to be easily understood.

of C in the version of Unix available from Bell Laboratories and supported by AT&T. Moreover, AT&T's recently announced series of computers, most of which will offer C and Unix as standard features, will be a determining force in even more firmly establishing Bell's version as the official standard for C.

The standardization of C will ensure compatibility not only among the compilers on different Unix systems, but also among the versions of C written for other operating systems. Even now the C compilers for CP/M and MS-DOS are being brought into line with the latest version from Bell Labs.

Unlike Pascal, C does not have to be extended to be useful for applications; indeed, the current standard from Bell Labs has evolved specifically as a result of active applications development. If you want to customize the language for your own purposes, you can simply add your extensions to the library.

In the programmer's eternal search for the perfect computer language for applications development, C has much going for it. It offers the structured programming, consistency, and clarity of style featured in the most modern high-level languages. But it can also be speeded up by using its special operations to emulate any particular microprocessor chip. By removing the input and output routines from the main body of the language and putting them in a standard library for easy modification, C programs can be extremely transportable to different computers. This flexibility of software amid a diversity of hardware may help to keep many software houses afloat during the turbulent 1980s. ☐

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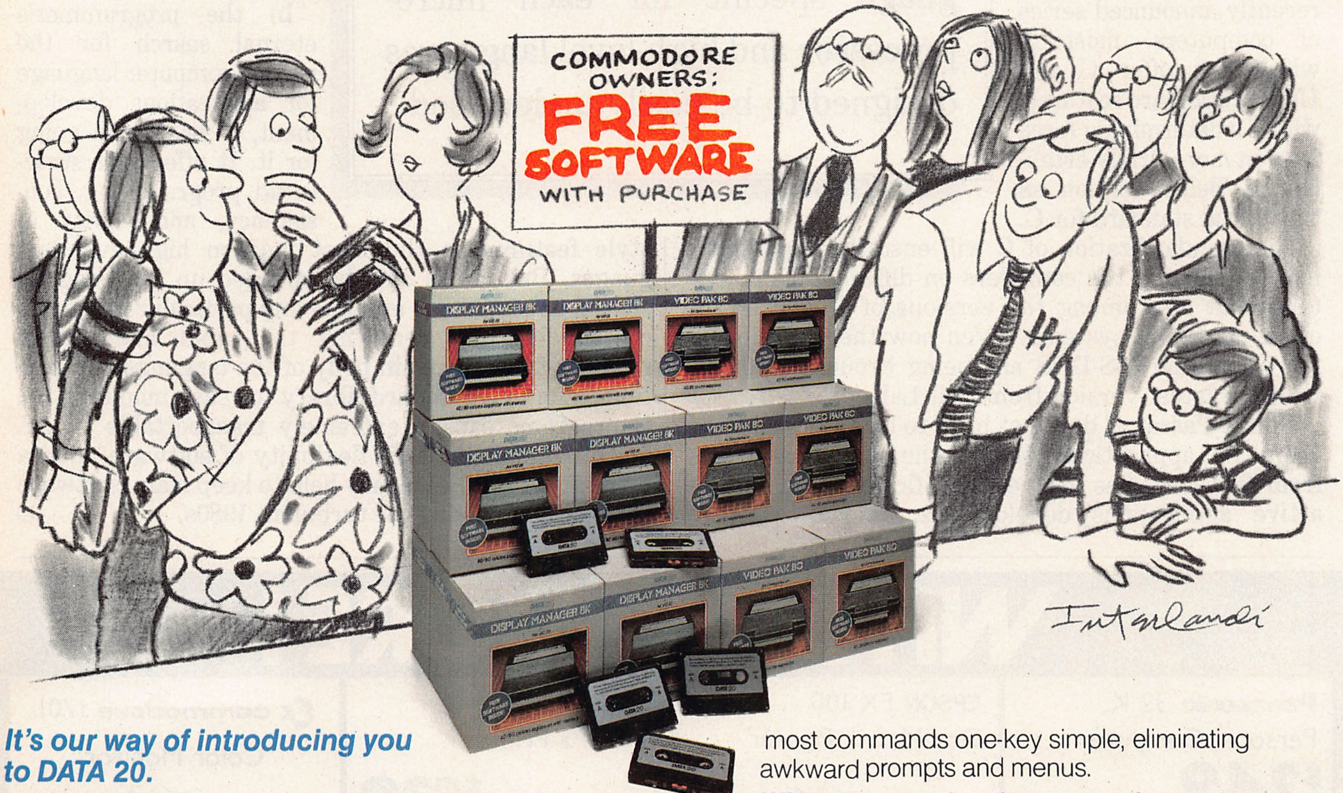

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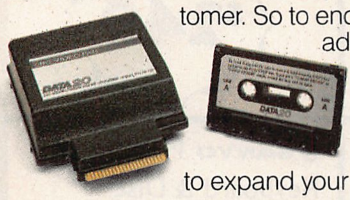

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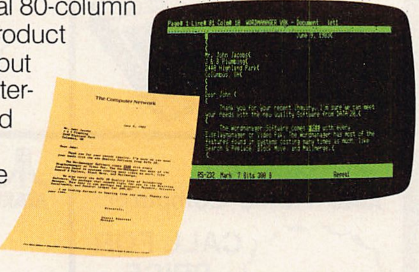

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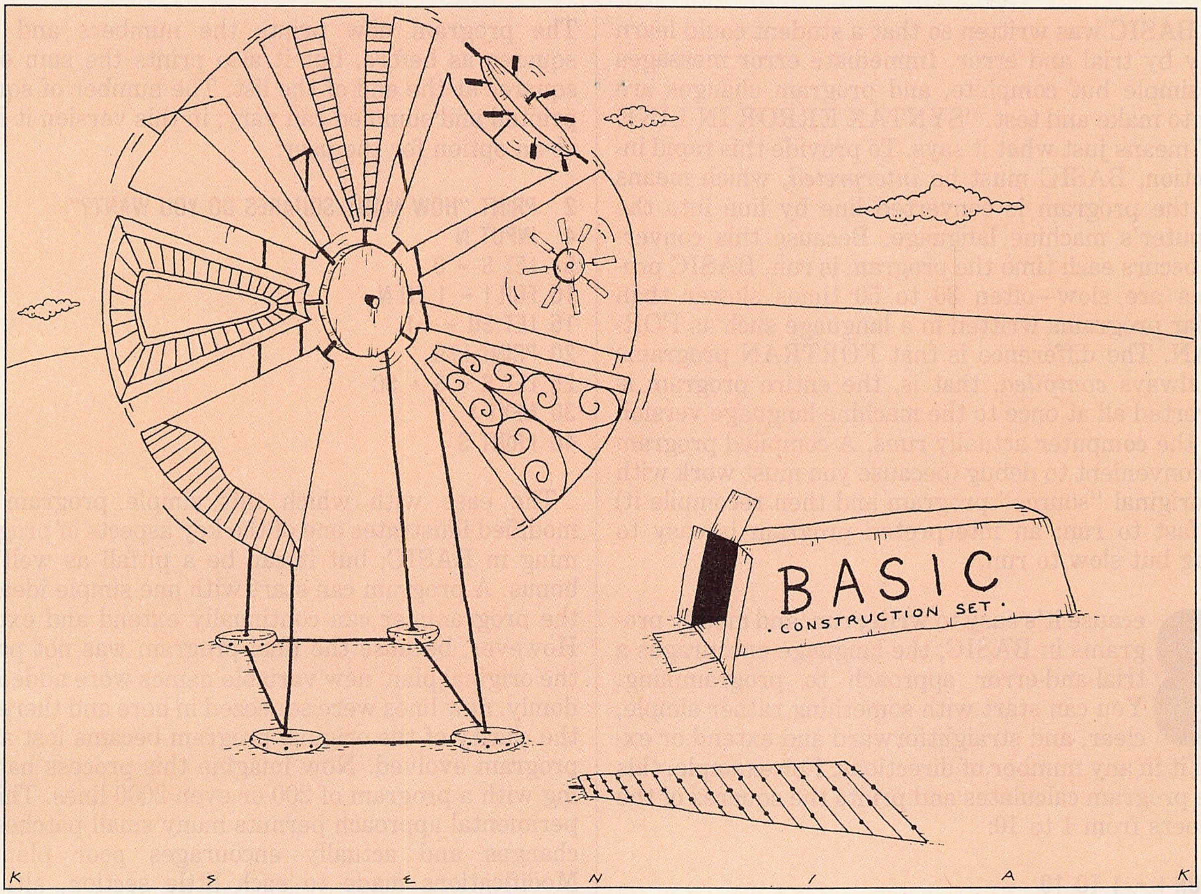
BASIC

The universal micro language that's easy to learn and easy to hate



BY MAHLON G. KELLY

The name BASIC stands for Beginner's All-purpose Symbolic Instruction Code. The language suits beginners because it was designed by Dartmouth professors John G. Kemeny and Thomas Kurtz to let students use computers without worrying about the formal, picky syntax found in other languages. It's an all-purpose language because it was intended for use by students of the humanities as well as by scientists and engineers. BASIC's designers were convinced that any educated person should know a little about computers.

Kemeny and Kurtz succeeded beyond what anyone could have expected. BASIC is available for every personal computer, and it's usually provided free, often permanently embedded in the *firmware* (read-only memory) of the machine. Anyone using a personal computer will understand the machine better if he or she learns at least a little BASIC.

Features and Problems

BASIC has one major advantage: it's easy to use. But users of BASIC will also encounter several distinct disadvantages: BASIC programs run slowly; it's easy to write confusing, poorly organized code; and it's difficult to translate from one of the many versions of BASIC to another (see "Translating BASIC Programs" on page 230).

These problems all stem from the language's ease of

Mahlon G. Kelly is an associate professor of ecology in the Department of Environmental Sciences at the University of Virginia.

Illustration by Mark Kseniak

use. BASIC was written so that a student could learn easily by trial and error. Immediate error messages are simple but complete, and program changes are easy to make and test. "SYNTAX ERROR IN LINE 540" means just what it says. To provide this rapid interaction, BASIC must be *interpreted*, which means that the program is converted line by line into the computer's machine language. Because this conversion occurs each time the program is run, BASIC programs are slow—often 30 to 50 times slower than similar programs written in a language such as FORTRAN. The difference is that FORTRAN programs are always *compiled*, that is, the entire program is converted all at once to the machine-language version that the computer actually runs. A compiled program is inconvenient to debug (because you must work with the original "source" program and then recompile it) but fast to run; an interpreted program is easy to debug but slow to run.

Because it's easy to write, run, and modify programs in BASIC, the language encourages a trial-and-error approach to programming. You can start with something rather simple, clear, and straightforward and extend or expand it in any number of directions. For example, this little program calculates and prints the squares of the numbers from 1 to 10:

```
10 FOR I = 1 TO 10
20 PRINT I,I*I
30 NEXT I
```

The comma in line 20 tells the computer to print the two numbers I and I*I in separate columns. When you type RUN, you'll see the result immediately:

```
RUN
1    1
2    4
.    .
10   100
```

If you want the program to print the *sum* of the squares, you can define two new variables, S and SQ, and add a few new lines:

```
5  LET S = 0
10 FOR I = 1 TO 10
15 LET SQ = I*I
20 PRINT I,SQ
25 LET S = S + SQ
30 NEXT I
40 PRINT S
```

The program now prints the numbers and their squares as before, but it also prints the sum of the squares at the end of the list. The number of squares printed and summed can vary; in this version it is left as an option for the user:

```
2  PRINT "HOW MANY SQUARES DO YOU WANT?"
4  INPUT N
5  LET S = 0
10 FOR I = 1 TO N
15 LET SQ = I*I
20 PRINT I,SQ
25 LET S = S + SQ
30 NEXT I
40 PRINT S
```

The ease with which this simple program was modified illustrates one of the key aspects of programming in BASIC, but it can be a pitfall as well as a bonus. A program can start with one simple idea that the programmer can continually extend and expand. However, because the final program was not part of the original plan, new variable names were added randomly, new lines were squeezed in here and there, and the clarity of the original program became lost as the program evolved. Now imagine this process happening with a program of 200 or even 2000 lines. This experimental approach permits many small patches and changes and actually encourages poor planning. Modifications made to each little section, although clear enough at the time they are first introduced, eventually become obscure even to the programmer and virtually incomprehensible to anyone else.

The careful programmer can proceed in a more organized way and design BASIC programs that are well structured, properly commented, and relatively easy to read. But it's so easy to learn BASIC in a haphazard way that the language as a whole has developed a reputation for fostering bad programming habits.

Chief among these bad habits is the frequent use of the GOTO command, which allows transfer of control from any line in a program to any other line. If a series of lines were drawn to show the sequence of command execution in a complex BASIC program, they would tend to overlap and interweave like strands of spaghetti, leading to the pejorative term "spaghetti code."

Of course it's possible to write convoluted programs in languages such as FORTRAN or COBOL, but it's much less likely. The very fact that the language is compiled rather than interpreted encourages better

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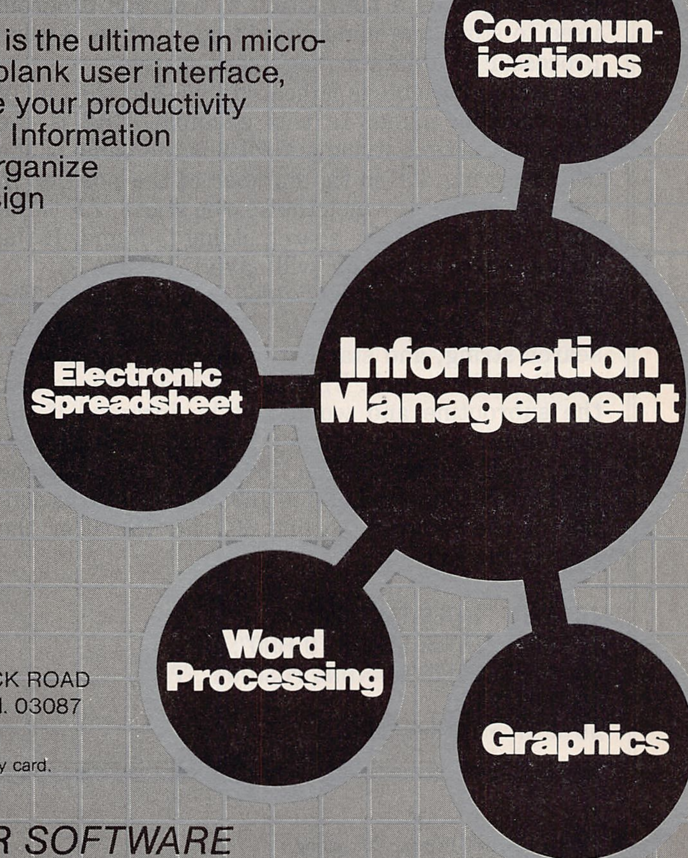

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THE INNOVATORS IN MICROCOMPUTER SOFTWARE planning because the entire program must be recompiled after even a minor change. Structured languages like Pascal make it even harder to write poorly organized programs because they don't allow you to jump from one line to another at will. The cost of this enforced structure is a loss of flexibility, however, so both approaches have their champions.

Because the original Dartmouth BASIC was so limited in its capabilities, many newer dialects of BASIC have been produced. The original American National Standards Institute (ANSI) guidelines that Kemeny and Kurtz followed were quite primitive. (A new ANSI standard has been proposed and will probably be accepted soon.) Nearly every BASIC used on today's microcomputers has been enhanced, often with specialties and options tailored to a particular machine.

Most microcomputers run versions of BASIC that are capable of sophisticated string manipulation, single- and double-precision arithmetic, and transcendental functions. The most sophisticated equipment, such as that produced for engineers by Hewlett-Packard, can do sophisticated matrix manipulation. The primitive nature of the original BASIC and the need for versions tailored to the various machines have produced so many dialects that it has become very arduous to "transport" a program from one machine to another.

So BASIC has problems. Why then is it sold with almost every personal computer? Perhaps it's because the earliest manufacturers such as Apple, Commodore, and Radio Shack wanted a language that would be easy to learn. Or perhaps it's because even

Sample BASIC Program

This small program was taken from "Translating BASIC Programs" on page 230. It illustrates BASIC commands that manipulate string variables. Its purpose is to determine whether a particular string (called a *search string*) is contained within another string (the *text string*). This program might be a subroutine in a larger program used to store and manipulate text, such as a word processor or a data management system.

A string variable is indicated by a $ at the end of the variable name. In this example, ZA$ is the name of the text string and ZB$ is the name of the search string. ZP is the number of the position in the text string at which the search starts. ZF is the position at which the search string is found. If the string is not found, ZF will have the value 0.

The program itself is divided into two parts. The first part allows a user to identify a text string, search string, and starting position and prints the result of the search. This part is used only to test the subroutine and would not be included if the subroutine were in a larger program. The subroutine itself begins in line 100 and ends with the RETURN command at line 160, which returns control of the program to line 50, the line after the subroutine call.

```
10 INPUT "ENTER TEXT";ZA$
20 INPUT "ENTER STRING TO FIND";ZB$
30 INPUT "ENTER STARTING POSITION";ZP
40 GOSUB 100
50 IF ZF = 0 THEN 80
60 PRINT "FOUND AT POSITION";ZF
70 GOTO 10
80 PRINT "NOT FOUND"
90 GOTO 10

100 ZF = 0:REM START OF SUBROUTINE
110 FOR ZJ = ZP TO LEN(ZA$) - LEN(ZB$) + 1
120 IF ZB$ < > MID$(ZA$,ZJ,LEN(ZB$)) THEN 150
130 ZF = ZJ
140 ZJ = LEN(ZA$) - LEN(ZB$) + 1
150 NEXT ZJ
160 RETURN
```

In the subroutine from line 100 to line 160, the value of ZF is initially set to 0. If the string is not found, this value never changes. Lines 110 to 150 are a FOR-NEXT loop in which the loop variable ZJ increases from the value of the starting position (ZP) to a number that is one more than the difference between the lengths of the two strings. Line 120 is the key comparison. It checks to see whether the search string is equal to the part of the text string that starts at the present value of ZJ. If it is *not* equal, the condition in line 120 is *true* and control is transferred to line 150, where ZJ is increased by one and the loop is repeated. If it *is* equal, the condition is *false* and lines 130 and 140 are executed, setting the values of ZF to the present value of ZJ and then setting ZJ to the value that ends the loop (see line 110). Once the loop has ended, line 160 returns control to the line 50 of the main program.

before an Apple was in anyone's eye hobbyists working with the archetypal MITS microcomputer had written simple BASIC interpreters that were easily converted for commercial use. But it seems most likely that BASIC is so widely used because it easily lends itself to writing the sort of short, interactive programs that are the essence of using a personal computer. Indeed, a computer with built-in BASIC doesn't even need a program—a direct statement can be typed from the keyboard to learn the status of the computer. PRINT FRE(0) tells how much memory is left, PRINT A$ shows the value of A$ during the last run, or PRINT PEEK(12050) will show the contents of memory location 12050. In short, BASIC actually works as an extension of the computer's operating system.

> Although many advanced programmers often complain about its faults, BASIC is still the least intimidating computer language, particularly for those novices who are eager for their first crack at programming.

Advantages of BASIC

If you're uncomfortable with programming, BASIC will certainly ease your anxiety. You can do with BASIC almost anything that you can do with other languages, and there's no better way to gain the feeling that you know how to use your computer than by writing a short BASIC program.

Interpreted dialects of BASIC are slow because they were designed for interactive learning, but BASIC can be compiled as easily as any other language. At least one BASIC compiler makes the language much faster than FORTRAN; ZBASIC (for the

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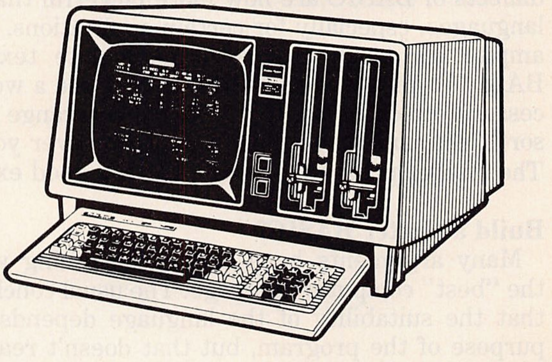

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TRS-80 or LNW-80) will run much more quickly than Microsoft's FORTRAN, and compiling a ZBASIC program is almost as quick as interpreting a normal BASIC program. This highlights one of the big advantages of BASIC: it can be either an interpreted or a compiled language. You can use an interpreter to write and perfect a program and then compile it for rapid execution.

Are the confusing dialects of BASIC really a disadvantage? Actually, a de facto standard does exist. In 1977 Microsoft developed a BASIC dialect that was adopted by Tandy, Apple, Commodore, and several other manufacturers. As a CP/M version it became available for almost all systems. You can run a program written in Microsoft BASIC on almost any microcomputer—while dialects are tailored to different machines, converting from one to another is not a problem. Even if you have a specialized, nonstandard BASIC it's still not too difficult to make conversions. *The BASIC Handbook*, by David Lien (see "BASIC Books" at right), explains how to translate from almost any dialect of BASIC to another. I've found only one insoluble translation problem: the matrix inversion function in Hewlett-Packard's BASIC is not available in Microsoft BASIC. Try converting a standard FORTRAN or COBOL progam from one mainframe's version to another and you'll find that all languages have dialects.

BASIC is a living language. It can be changed to fit various applications and to accommodate new technology as needed. If you buy a computer in 1995, the chances are that it will support a dialect of BASIC that you'll be able to understand.

Early BASICs were not very powerful, but many dialects of BASIC are now more powerful than other languages, especially for certain applications. For example, it's much easier to manipulate text using BASIC than it is with FORTRAN. I use a word processor written in BASIC. You can rearrange strings, sort them, and move them around however you wish. The sample program on page 124 is a good example.

Build a Better BASIC?

Many arguments have arisen concerning which is the "best" computer language. The usual conclusion is that the suitability of the language depends on the purpose of the program, but that doesn't really hold for BASIC. There are so many dialects that BASIC is hardly a single language, and the best features of almost any language can be incorporated into a BASIC dialect. Because so many people have learned to program in BASIC, I will argue that we should not design new languages but simply produce new dialects of BASIC to serve different purposes.

It's certain that more people are able to program in BASIC than in any other language, and having various versions of BASIC lets us spend less time learning languages and more time programming. It may be just as inappropriate to force personal computers to "speak" Ada, COBOL, FORTRAN, or a standardized BASIC as it is to ask all humans to speak Esperanto. □

BASIC for Microcomputers

- BASIC-80, from Microsoft Consumer Products (10700 Northup Way, Bellevue, WA 98004) runs on Z80/8080/8085-based microcomputers with the CP/M operating system.
- Structured BASIC Compiler, from Westico (25 Van Zant St., Norwalk, CT 06855) runs on Z80/8080/8085-based computers with the CP/M operating system.
- Compiler BASIC, from Compiler Systems Inc. (POB 145, Sierra Madre, CA 91024) runs on computers with the CP/M operating system.
- CB-80, from Digital Research Inc. (POB 579, Pacific Grove, CA 93950) runs on CP/M and MP/M operating systems.
- Integer BASIC Compiler, from Synergistic Software (Suite 201, 830 North Riverside Dr., Renton, WA 98055) runs on Apple II and III.
- Structured BASIC Translator, from Acorn Software Products Inc. (1945 Gallows Rd., Vienna, VA 22180) runs on Radio Shack TRS-80 Models I, II, and III.
- BAZIC High-Level Interpretive Language, from Micro Mike's Inc. (1009 South Virginia St., Amarillo, TX 79101) runs on Z80/8080/8085-based computers.
- BASIC interpreters are also available from every manufacturer of microcomputers.

BASIC Books

Albrecht, Bob; Inman, Don; and Zamora, Ramon. *TRS-80 BASIC*. New York: John Wiley and Sons, 1980.

Gosling, Peter. *Program Your Microcomputer in BASIC*. Beaverton, OR: Dilithium Press, 1981.

Lamoitier, J. P. *BASIC Exercises for the IBM Personal Computer*. Berkeley, CA: Sybex, 1982.

Lien, David A. *Learning TRS-80 BASIC*. El Cajon, CA: Compusoft Publishing, 1982. (Also available for other computers under similar titles.)

__________. *The BASIC Handbook*. El Cajon, CA: Compusoft Publishing, 1981.

Weber, Jeffery R. *BASIC Programs You Can Use, CP/M edition*. Weber Systems, 1983. (Editions for other computers also available.)

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Special Report

But Why Hasn't It Taken The World By Storm?

FORTH Inspires A Fanatic Following

BY DARA PEARLMAN

To the outsider looking in, FORTH is full of puzzles. Developed in the late 1960s by one man as his own personal programming tool, this unconventional computer language, spreading largely by word of mouth, has attracted a small army of followers. These devotees include all kinds of computer buffs, from professors and successful businessmen to misfit midnight hackers. They call themselves the FORTH community and meet as chapters of the FORTH Interest Group (FIG) to trade technical information and debate fine points of the FORTH philosophy. Some enthusiasts go even further, devoting most of their spare time to spreading their belief that FORTH is the natural language for communicating with a computer.

But lest you dismiss these fanatics as quasi-religious high-tech groupies, consider the following:

- •Many of the corporate computer giants, including Hewlett-Packard and IBM, use FORTH for in-house development projects.
- •FORTH is the standard control language for sophisticated astronomical observatories all around the world. Other FORTH systems guide automated movie cameras, run portable heart monitors, and simulate radars for the Air Force. Still others perform more familiar database management and word-processing tasks on personal computers.
- •FORTH is compact. Its operating system, compiler, interpreter, and editor can fit in less than 8K bytes of memory, and a run-time applications program can be smaller than 1K bytes.
- •FORTH is fast. When optimized for a particular machine, FORTH programs can run as fast as comparable assembly-language programs.
- •FORTH programmers get the job done. Programmers who switch to FORTH often report increases in productivity of 300 percent and more.

And thus the puzzle: if FORTH is so good, why hasn't it taken the computer world by storm? And if it's not a software breakthrough, how does it attract such a devoted following?

FORTH programmers often explain the language's attraction in terms of the increased power they have over the computer. They compare FORTH to a manual transmission—it makes the car more responsive to the driver, but it's also more work and less forgiving of mistakes than an automatic transmission. And while it appeals to a certain kind of driver, it will never dominate in an automatic-transmission world.

Dara Pearlman is a freelance writer living in Sunnyvale, California.

FORTH DIMENSIONS
FORML CONFERENCE ASILOMAR, CA. 1981
FIG
FORTH DIMENSIONS
MATH EDITION
HARDWARE CONTROL
BUSINESS APPLICATIONS

The original FIG Five (l. to r.): Kim Harris, Dave Boulton, Bill Ragsdale, John James, and Dave Kilbridge.

In addition, FORTH fans insist that the language has not yet found all of its natural audience because of the unique way it developed. Unlike the mainstream computer languages such as FORTRAN, BASIC, COBOL, and Pascal, FORTH grew up outside academia, government, and the major corporations. No one with clout has promoted the language. Instead, it has grown slowly, gaining popularity largely because of grass-roots efforts. Working alone, Charles Moore invented FORTH, placed it in the public domain, and formed FORTH Inc., a company that promoted FORTH as the solution to specialized scientific and manufacturing problems (see "Charles Moore: Reluctant Prophet" on page 132).

Photograph by Roger A. Lee

FORTH fanatics Tom Dowling, Jill Miller, and Dick Miller (l. to r.).

Photograph by Peter Vandermark

Throughout the early and mid-1970s, FORTH remained an obscure computer language, but it did carve out a definite niche and slowly gained adherents. Astronomers familiar with Moore's work at the Kitt Peak National Observatory were the first to enthusiastically adopt the new language. Across the ocean, FORTH programmers formed the European FORTH Users Group and began work on international FORTH standards. Meanwhile, FORTH Inc.'s sales efforts in this country attracted a few more converts. One of them was a young physicist turned software engineer named Kim Harris.

Harris, who was working for an electronics firm in California's Silicon Valley, had a problem. The firm was trying to develop an inventory system on a microcomputer based on Motorola's 6800 microprocessor. Members of Harris's design group were impatient with assembly language because progress was too slow, but all the higher-level languages they investigated required too much memory. Then someone noticed an ad for a FORTH Inc. seminar.

"It was free, and I figured it might be useful, so I went," Harris recalls. What he heard both angered and intrigued him. "I had 10 years of programming experience, and I was incensed by the wild, absurd claims that couldn't possibly be true." And yet Harris couldn't completely dismiss it as advertising hype because he saw a very convincing demonstration. In only 15 minutes, a FORTH programmer developed a simple program to play computer music. Harris happened to know a skilled hobbyist who had been working for more than a year to produce a similar program in assembly language. "It was like a religious miracle, and I saw it myself," says Harris.

On the strength of the demonstration, he convinced his company to invest $2000 in a FORTH Inc. system on the chance that it might be useful. Harris remembers his feelings as he learned the new language: "I felt like Alice in Wonderland. Things got curiouser and curiouser. They still didn't make sense, but I saw how they might make sense." His group went on to complete a project in FORTH that was half the size of a comparable assembly-language program.

Harris wasn't able to keep using FORTH on the job when he moved on to a different company, but his fascination with the language continued. He teamed up with four other FORTH fanciers to found the FORTH Interest Group, the organization that was destined to pull FORTH out of obscurity by creating versions of it for the rapidly growing ranks of home computer hobbyists.

The year was 1977, the dawn of the personal computer age in the San Francisco Bay area. It was an exciting time: meetings of the Homebrew Computer Club drew crowds of more than 500 computer enthusiasts who were building their own machines and wanted to trade ideas on what the infant technology could do.

While attending such meetings, the original "FIG Five" found each other. In addition to Harris, they were Bill Ragsdale, John James, Dave Boulton, and Dave Kilbridge. They shared the same age bracket (mid-20s to mid-30s), excellent technical backgrounds, and a passion for FORTH. "We were like people with the same disease who get together to trade war stories," jokes Harris. "Because there were five of us, we figured we must be a club."

During 1978, other FORTH enthusiasts and family members helped with the group's first projects, a newsletter entitled *FORTH Dimensions* and FIG's first public meeting, a "teach-in" that drew 40 people. While the response to their efforts was heartening, a major stumbling block remained: the lack of a good, low-cost FORTH system for the homebrew hobbyist. FORTH Inc., whose least expensive system was priced at $2000, was not interested in the personal computer market. Some other vendors were selling systems that the FIG members felt were giving FORTH a bad name. Bill Ragsdale recalls, "We wanted to intimidate vendors into doing it the right way. We decided that if FORTH Inc. wasn't going to rise to the challenge, we would." And thus the FORTH Implementation Team (FIT) was born.

Ragsdale, the founder of Dorado Systems, a successful Hayward, California, electronics company, was the team's main instructor and prime mover. He had written his own FORTH system to program his company's hardware after learning that FORTH Inc. couldn't meet his needs. In a series of Saturday lessons he taught the other team members how his system worked. Their homework was to translate the system to run on the computers they had at home.

> Why did 12 crackerjack programmers devote the lion's share of their spare time for half a year to create a product that they would essentially give away? 'We wanted to give the world this thing and set it on its heels.'

The team, composed of the FIG Five and seven volunteers, labored evenings and weekends for more than six months to produce FIG-FORTH, a FORTH system that ran on six different computers. It was ready in time for the 1979 West Coast Computer Faire in San Francisco, where FIG members introduced the system, demonstrated its features, and sold printed source-code listings and installation manuals for $20. Since then, FIG-FORTH has attracted more and more followers and become the most widely used FORTH dialect, a degree of success that astonished even the team members themselves.

So now we find another puzzle from the world of FORTH: why did 12 crackerjack programmers devote the lion's share of their spare time for half a year to create a product that they would essentially give away?

The best answer seems to be that these FORTH fanciers were imbued with a kind of technological altruism. "Perhaps our motives seem absurd and naive today," explains Harris. "We were young and idealistic. We wanted to give the world this thing and set it on its heels, and everyone would be better off." Another factor he points to was the excitement of the times, the mini-renaissance of Silicon Valley in the late 1970s: "We weren't hungry. We had no problem with work, but there was surplus creativity we didn't use on the job. We wanted to explore the limits of what these machines could do. Now that we had them built, maybe we needed to justify the expense. To say 'I'm writing a FORTH compiler' was as good an excuse as any."

Ironically, while the implementation team members were laboring to produce a FORTH dialect to serve as a model for vendors, the FIG activists got behind on their mail and thus missed the opportunity to influence a major commercial FORTH dialect that was just then taking shape on the other side of the country. On the shores of Lake Cochituate in Natick, Massachusetts, Dick and Jill Miller had just decided that FORTH might be the answer to their problems.

The Millers had also been caught up in the excitement of the dawning microcomputer age in 1977. As active volunteers in the Lake Cochituate Watershed Association, they began looking for a microcomputer to help keep tabs on a planned environmental research project. Jill was then a computer consultant specializing in large IBM mainframes, and Dick was an electro-optical physicist with some experience in an early form of BASIC.

They ordered one of the first TRS-80 microcomputers with their own money, expecting to be paid back from research grant funds. The Environmental Protection Agency failed to approve the research project, but the Millers never regretted their purchase. They formed Miller Microcomputer Services and by 1978 were running a booming consulting business. And BASIC was their problem.

They wanted to speed up development time for custom computer programs in order to make software as affordable as the hardware was becoming. They investigated Pascal and other compiled languages, but none was yet available for the TRS-80. Then Dick Miller attended a FORTH Inc. presentation. "It sounded like tricks you do with mirrors," he recalls. He simply didn't believe a language could be that good. But he was intrigued enough to attend another presentation six months later, which enticed him further. The Millers finally decided to invest $3000 in a FORTH Inc. system.

But it wasn't going to be that easy. FORTH Inc., he then learned, didn't sell a TRS-80 system and had no plans to develop one. "By late 1978 we really wanted FORTH. We met Tom Dowling, an excellent FORTH programmer who had put in a number of professional FORTH installations. In his spare time he was puttering with a friend's TRS-80," Miller remembers.

Dowling teamed up with the Millers to develop MMSFORTH, now one of the major versions of FORTH for microcomputers (more than 300 systems for TRS-80s and IBM Personal Computers have been sold). While Dowling was working on the first version, the Millers heard of FIG's activities. They wrote for information but didn't receive an answer until MMSFORTH was already finished.

Today the Millers still operate Miller Microcomputer Services out of their lakefront home, personally answering customers' questions every weekday from 9 a.m. to 9 p.m. They employ 12 other programmers who mostly work in their own homes, some in distant states. "It's a state-of-the-art cottage industry," jokes Miller. "Just like knitting sweaters, except with microcomputers." In addition to their MMSFORTH systems, the Millers' business sells a number of applications programs written in FORTH and continues to do consulting and custom programming.

The Millers did finally get to know the leaders of FIG during meetings to hammer out the FORTH-79 standards, which now serve as the basis for MMSFORTH and many other commercial FORTH systems. Relations are cordial for the most part, but Dick Miller does wish FIG would get out of the FIG-FORTH distribution business. He feels that the nearly free FIG-FORTH system undercuts commercial vendors and gives the computing public the erroneous impression that FORTH is obscure and not well supported. He also points out that FIG-FORTH, which FIG still sells as printed listings, is the only major FORTH

Charles Moore: Reluctant Prophet

Imagine a sculptor who dreams of creating a statue but finds his attempts frustrated by imperfect tools. So he experiments with different designs and slowly develops a tool that lets him create the sculptures of his dreams. Soon other sculptors discover his tool and begin to popularize its use. A few design and sell their own versions, building successful businesses. But the inventor, pleased though he is that others find his tool so useful, backs away from actively promoting it. "My goal was not to amass money," he explains. "It was to have fun."

Change the context from sculpture to computer programming and you have the story of Charles Moore and the development of FORTH. Moore, now 44, began working on his programming tool in the early 1960s. He had become acquainted with computers in 1956 when he was still an undergraduate physics student at Massachusetts Institute of Technology with a job at the Smithsonian Astrophysical Observatory. He thought a computer might help out in the many calculations needed for satellite tracking, so he learned the programming language FORTRAN.

Moore's subsequent computer experience included a stint at the Stanford Linear Accelerator in California, several years as a freelance programmer, and a job with Mohasco Industries, a carpet manufacturer in Amsterdam, New York. While working with many computers and many languages during this time, he experimented with stack structures, reverse Polish notation, interactive interpreters, and the other elements he later combined in FORTH. He didn't set out to create a new computer language—his goal was simply to make himself a more productive programmer. He calculated that with FORTRAN he could write perhaps one good program each year. With FORTH, he could work at ten times that rate.

By the late 1960s, when his programming tool was mature enough to need a name, Moore was working at Mohasco Industries on an IBM 1130, a "third-generation" computer. He felt that his new language was a leap into the fourth generation, but because the IBM 1130 would accept only five-letter identifiers, "Fourth" became "FORTH."

(The name was a happy choice that has sparked many playful adaptations. Leo Brodie titled his popular instructional book *Starting FORTH*. A word-processing program is called FORTH-WRITE, a FORTH programmer's consulting firm is called Go FORTH, and a T-shirt logo that makes dialect that is outdated—it doesn't comply with the 1979 standards.

Miller has found a sympathetic listener in FIG president Bill Ragsdale. Ragsdale doesn't agree that FIG-FORTH competes with commercial FORTH packages, noting that a user has to be a pretty sophisticated assembly-language programmer to turn the printed listing into a working system. On the contrary, he thinks FIG-FORTH has created a market for Miller and others to exploit by giving programmers a taste of FORTH and an appetite for more. However, Ragsdale does support Miller's contention that FIG-FORTH is obsolete, and he has tried to convince the rest of the FIG board of directors to stop selling the FIG-FORTH listings. Other board members don't necessarily agree, though, and they have countered that as a public-domain product with more than 25,000 copies in circulation, FIG-FORTH won't just go away. If FIG doesn't sell it, someone else will.

Instead, some FIG activists would like to see the organization distribute a new FIG-FORTH updated to comply with FORTH-83 standards now being developed. Kim Harris is a member of this camp, and along with FIG members Henry Laxen and Mike Perry he was written a proposed new version.

But if Ragsdale has his way, that won't happen. FIG-FORTH, he believes, has done its job. It gave the language exposure and a public, and now the marketplace can take over. That market now supports more than 150 vendors of FORTH-related products that range from textbooks to turnkey systems. In fact, according to Roy Martens, FIG's business manager, sales of commercial FORTH packages are increasing while FIG-FORTH sales are slipping.

Martens is also the head of Mountain View Press, a major mail-order distributor of FORTH products, but until 1980 he had never heard of FORTH. He was

even some FORTH enthusiasts cringe proclaims, "May the FORTH be with you.")

When Moore went to work for the National Radio Astronomy Observatory in Charlottesville, Virginia, in the early 1970s, he developed his new language to the point that it was used for the programs that control the 36-foot radio telescope at Kitt Peak National Observatory in Arizona. During this project he worked closely with Elizabeth Rather, "the world's second FORTH programmer," who later joined with him to form FORTH Inc.

In 1973, Moore and Rather founded the new southern California company in response to demands from astronomers who wanted to duplicate the successful operation at Kitt Peak. Soon they branched out into other markets as well.

Not long ago Moore left FORTH Inc. The corporation, he explains, wanted to concentrate on selling PolyFORTH, the company's FORTH language system. "I have never been interested in promoting FORTH as a solution to other people's problems. It's the way I want to work, and if other people want to use it too, that's fine. But I make more money and have more fun using FORTH to program applications," he says.

Moore, who answers questions about his career in short, crisp sentences, waxes eloquent when the conversation turns to FORTH and its underlying philosophy. What is that philosophy? "In a word, simplicity. The world is a complicated place and technology seems bent on making it even more complicated. That's wrong in all kinds of profound ways. It's wrong in human terms. It's wrong in social terms. It's wrong in computer terms."

Unreliability is the consequence of complexity, Moore believes. FORTH "requires the conviction that compactness is both possible and desirable. It has one command: do things well."

"A good programmer can do a fantastic job with FORTH; a bad programmer can do a disastrous job," is an oft-quoted dictum of Moore's that he explains this way: "I spent 10 years trying to write a good FORTRAN program. At the end of that time I was marginally better than at the beginning. Languages like FORTRAN, Ada, and Pascal channel the programmer into particular ways of thinking. The aim is to prevent mistakes, but it also prevents serendipity. FORTH encourages new ways of expression." For the bad programmer this freedom of expression ~~is a~~ risk, but ~~it's a~~ boon to a more experienced one.

Moore thinks this freedom from strict rules, being a central feature of the language, may actually slow FORTH's wider acceptance: "There is a prevailing view that a language should protect a programmer from himself. FORTH gives the programmer freedom, not rules."

Yet Moore is confident that more and more programmers will switch to FORTH. "It's a classic problem in technology. If you develop a new alloy, it has to be substantially better than what's already available to make an impact—say, 10 times better. FORTH is 100 times better than everything else. It's too good to be ignored." □

operating a one-man public relations firm in his Mountain View, California, home when Bill Ragsdale asked him to take over as publisher of *FORTH Dimensions*. Soon Mountain View Press also took charge of the printing and mail-order sales of FIG-FORTH. It was a natural jump from there to offering disk versions of FIG-FORTH.

Today, Mountain View Press and FIG activities take up four of the nine rooms in Martens' suburban home, not to mention the garage. The business has eight part-time and six full-time employees, including Martens' wife, Sari, and his sister, Betty Maddox, who lives next door. The business also fills two of her rooms (and her garage).

Is FORTH becoming a mainstream language? Ragsdale thinks it still needs a flagship company, a Microsoft or Digital Research, to make it truly prosper. He'd like to see FORTH Inc. take up that role, and he's in a position to influence its direction. Three years ago he bought a large block of FORTH Inc. stock, and now he's the corporation's chairman.

Kim Harris thinks the world might just adopt FORTH when programmers get "hungry enough." He predicts that "a window is coming now for FORTH's acceptance. People have to try the new generation of languages like Pascal and Ada and find out they don't solve all the problems. Then they'll be ready to try FORTH." □

FORTH Resources

If you want to learn more about FORTH, Leo Brodie's *Starting FORTH* (Englewood Cliffs, NJ: Prentice-Hall, 1981) is probably the best place to begin. Written in a light, entertaining style, the book achieves the admirable balance of neither talking down to novices nor skimping on meaty technical details. Brodie's clever illustrations (a hooded executioner bearing an ax depicts the EXECUTE function, a spring-loaded elevator represents the stack) help explain the concepts with a touch of humor.

Brodie is also the editor of *FORTH Dimensions*, the bimonthly magazine of the FORTH Interest Group (FIG). The magazine features tutorials, program listings, and theoretical articles such as "The Sheer Joy of Clipping Recursively." It also carries ads for FORTH products and workshops and a list of FORTH vendors. Subscriptions are free with membership in FIG, which has nearly 3800 members organized in 31 local chapters. To join, send $15 ($27 foreign air mail) to FORTH Interest Group, POB 1105, San Carlos, CA 94070. FIG also sells FIG-FORTH listings with installation manuals for $15, some FORTH books and articles, and FIG T-shirts featuring a bright green fig leaf. You can order these items by calling (415) 962-8653.

If you would like to attend some FORTH tutorials and see what vendors are offering, you might want to plan on the Fifth Annual FORTH Convention scheduled for October 14 and 15 at the Red Lion Inn in San Jose, California. Contact FIG for further information.

The nonprofit Institute for Applied FORTH Research in Rochester, New York, also sponsors an annual conference on FORTH and publishes the quarterly *Journal of FORTH Applications and Research*. For further information contact the Institute for Applied FORTH Research Inc., 70 Elmwood Ave., Rochester, New York 14611; (716) 235-0168.

FORTH Dimensions lists dozens of FORTH system vendors for dozens of computers. Without implying endorsements, we list here only the vendors mentioned in the accompanying article:

FORTH Inc.
2309 Pacific Coast Highway
Hermosa Beach, CA 90254
(213) 372-8493

Miller Microcomputer Services
61 Lake Shore Rd.
Natick, MA 01760
(617) 653-6136

Mountain View Press
POB 4656
Mountain View, CA 94040
(415) 961-4103

Of special interest is a budget computer that is perhaps the lowest-priced FORTH system. A new competitor for the Timex/Sinclair 1000, it's a $150 computer called the Jupiter Ace that features FORTH instead of BASIC as its "native language" in read-only memory. Designed in Britain by two young engineers who helped develop the Sinclair computers, the Jupiter Ace made its debut in this country at the 1983 West Coast Computer Faire. For further information, contact Computer Distribution Associates, 17 South Main St., Pittsford, NY 14534; (716) 385-6277.

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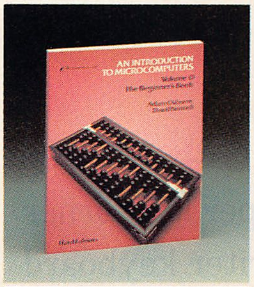

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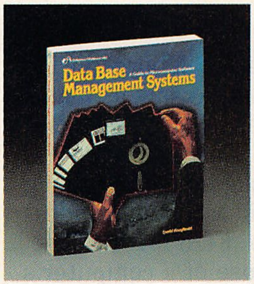

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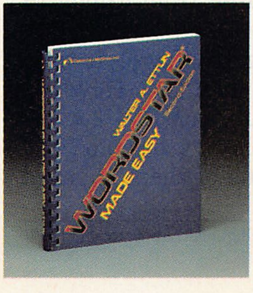

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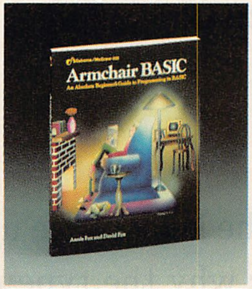

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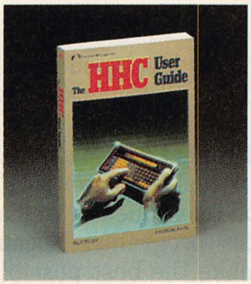

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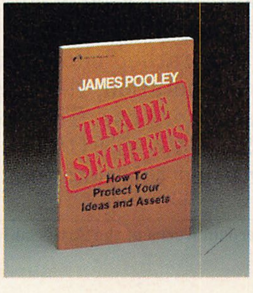

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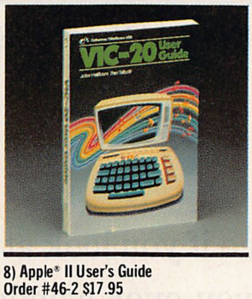

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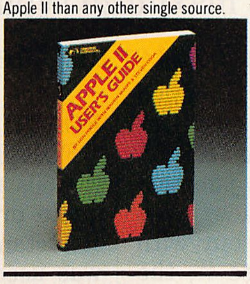

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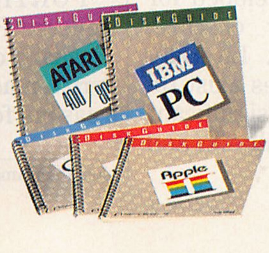

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Computer Languages Of The Future

BY JONATHAN AMSTERDAM

QWERTY. That's what you'll see if you look at the keys in the upper left corner of the nearest typewriter. Did you ever wonder why the typewriter keyboard was arranged that way? Does it maximize typing speed, minimize the energy it takes to type, or some such thing? After all, there must be some good reason for it, right? Wrong! The keyboard was actually designed to be *difficult* to type on because when the typewriter was invented over a hundred years ago, the technology could not handle fast typing—the keys jammed. Not much later, mechanical advances made typewriters capable of much faster operation, but with thousands of typists already trained to use it, the QWERTY keyboard stuck.

This story has many parallels, particularly in the area of programming languages. Many of today's most common languages occupy their privileged positions for no reasons other than that they got there first, they were backed by powerful organizations, or they were well advertised. But other languages, though not nearly as popular as the common ones, have still managed to flourish. Some of these less common languages were poorly designed or were developed for special applications and are deservedly obscure; others are too new to have made a stir. Literally thousands of uncommon computer languages exist today, but here we'll consider six of the most significant ones: FORTH, APL, LISP, Modula-2, Smalltalk, and PROLOG.

FORTH

FORTH was developed by Charles Moore during the 60s and 70s in response to what he saw as inadequate programming languages (see "Charles Moore: Reluctant Prophet" on page 132). Early on, FORTH was used in real-time control tasks such as guiding astronomical telescopes as well as in assorted business and graphics programs. Because FORTH was designed to make the best possible use of a computer's memory and speed, it's an excellent language for microcomputers. A typical FORTH program will run much faster and use much less memory than the equivalent BASIC program. Today, FORTH is available on almost every kind of computer, from Apples to IBM mainframes.

FORTH is a rather odd-looking language. It uses reverse Polish notation, the same kind that Hewlett-Packard calculators use. This means that 3 + 2 * 4 is written as 2 4 * 3 + in FORTH. There are some good reasons for using this notation. One of them is based

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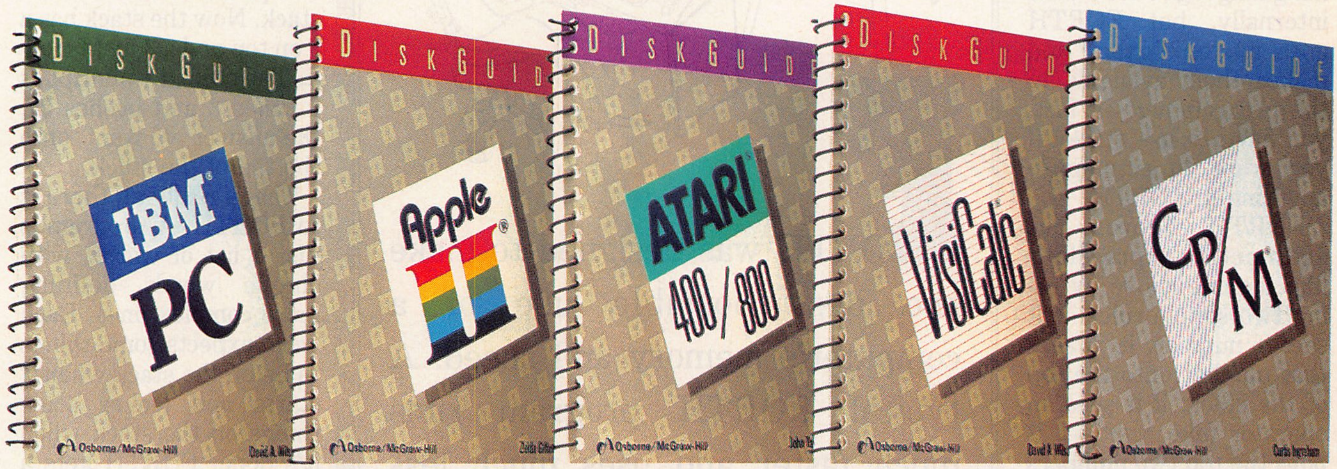

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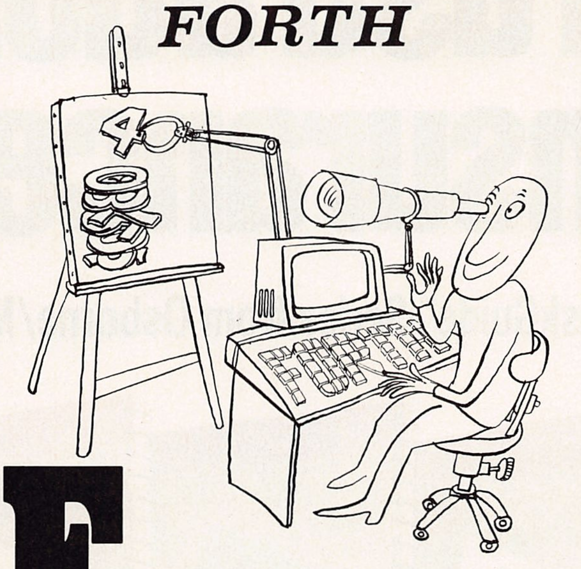
FORTH



FORTH was designed to make the best possible use of a computer's memory and speed. A typical FORTH program runs much faster and uses much less memory than the equivalent program in BASIC.

on the idea of a *stack*, a pile of objects from which you can add or remove only the top element, like a stack of dishes or cafeteria trays. All programming languages use stacks internally, but FORTH goes a step farther and makes them available to the programmer. In fact, you have to use stacks if you want to accomplish anything in FORTH.

FORTH figures out arithmetic expressions like the one above by using two simple rules: if it sees a number, it *pushes* that number onto the top of the stack; if it sees an operator (like * or +), it *pops* the top two numbers off of the stack, applies the operation to the numbers, and pushes the result back on the stack. If you try these rules on the expression 2 4 * 3 +, you'll see that you end up with 11 on the stack when you're done.

A FORTH program consists of the definitions of many *words*. What is known as a word in FORTH would be called a procedure or a subroutine in another language. Programmers use words integral to the language to define new words that, once defined, may be used to define still others. Let's define a FORTH word called CUBE, which will find the cube of a number:

```
:CUBE
 DUP DUP
  *   *
```

The colon character is a FORTH word used to define new words. After the colon we put the name of our new word, followed by the list of words that make up the definition. We signify the end with a semicolon.

If we wanted to find the cube of 3, we'd write 3 CUBE (remember, FORTH uses reverse Polish notation). This would push 3 on the stack and then execute the words that make up the definition of CUBE. The first of these words is DUP, which is a built-in word that tells the computer to duplicate the number on the top of the stack. So the two DUPs push three 3s onto the stack. The next word (*) pops the top two numbers off the stack, multiplies them, and puts the product back on the stack. Now the stack has a 9 on top and a 3 just below it. The second * multiplies 9 times 3 and pushes 27, the answer we want, onto the top of the stack.

That's really all there is to FORTH. A program is just a list of words, with simple words defining more complex ones. Each word expects some things to be on the stack when it starts and leaves some things on the stack when it's done. FORTH gets a lot of mileage from this simple idea. Because FORTH has so little work to do—just pushing and popping numbers from the stack and executing the definitions of words—it can be very small and fast. FORTH is also *extensible*, which means that it's possible to add new features to the language. If your version doesn't have floating-point numbers, for example, you can just define some words that perform the necessary operations. Given these words, your FORTH system will be able to do floating-point arithmetic, but most important, no one but you can tell that this capability wasn't a part of the original language. FORTH *primitives*—words that come with the system and are written in machine language—look just like user-defined words. FORTH can do even more than that—it also allows you to write words that define other words. Because they allow programmers to tailor FORTH to almost any application, these word-writing words are one of the most powerful aspects of the language.

Another much-touted FORTH feature is that, except for the primitive words and a very small machine-language program called the inner interpreter, everything in a FORTH system is written in FORTH, and all of it is accessible to and can be changed by the FORTH programmer. This allows you to customize any part of the system—the text editor, the assembler, or what have you—to meet your own needs. Program-

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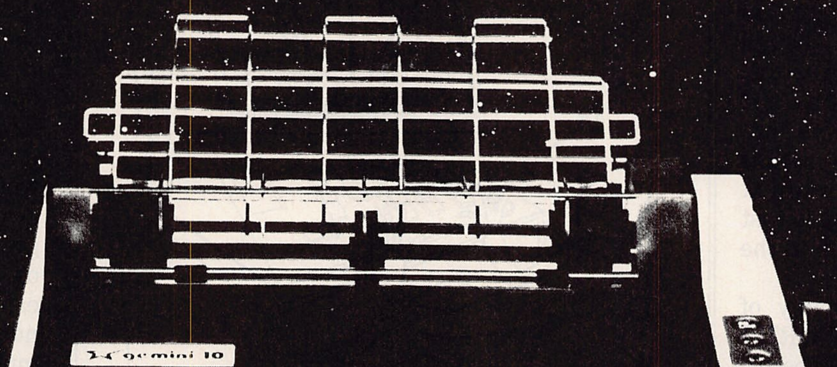

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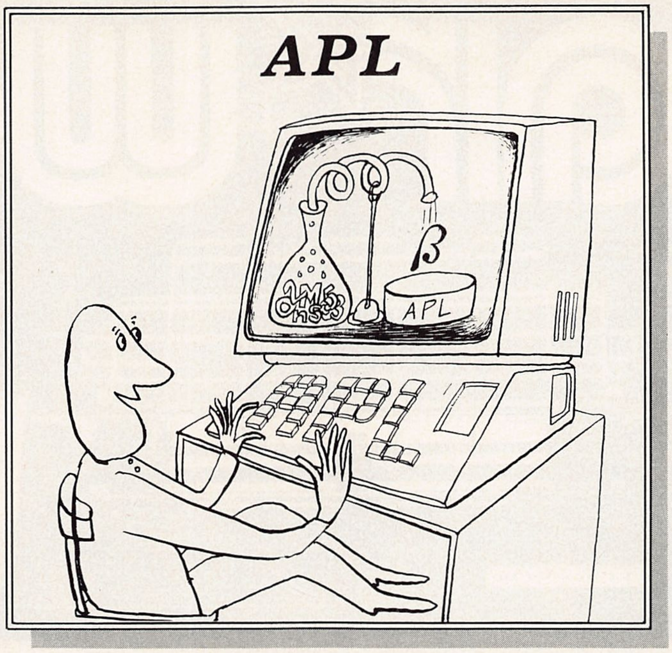


mers call such a system *integrated.* Also, though individual FORTH words are compiled, FORTH systems themselves are interpreted. This means you can write one word at a time and thoroughly test it before moving on to the next.

Paradoxically, many of the strengths of FORTH are also its weaknesses. Reverse Polish notation is hard to read, and it's a FORTH tradition to use words with strange names like single quotes, commas, exclamation points, and so on, making the language difficult to learn or read. Also, because FORTH tries to be fast, it doesn't bother with any of the safety checks that other languages perform (though you can redefine some words to do safety checks), and keeping track of what's on the stack at any given time can be difficult. All of this makes it tricky to debug FORTH programs. Moreover, while the ability to modify the system is great if you know what you're doing, God help you if you accidentally goof.

All in all, FORTH is an excellent language if you're interested in speed and enjoy controlling and changing your environment. It's perhaps a little less attractive to the novice programmer.

APL

APL (A Programming Language) was developed by Kenneth Iverson as a mathematical notation to help him teach his courses at Harvard. Somewhere along the line, it became a programming language, and it's still used a great deal at IBM. As you might guess from its origins as a mathematical notation, APL is rather concise. Here's an APL statement that will find the average of a list of numbers (called LIST):

```
(+/LIST)+ρLIST
```

The +/LIST part adds up the list of numbers; ρ LIST finds the length of the list; and the division sign stands for ordinary division. APL has a score of these funny symbols—one reason you'd have trouble running the language on your home computer is that it uses so many characters that aren't part of the familiar ASCII (American National Standard Code for Information Interchange) character set. Some of these symbols represent very powerful operations. For example, ⍒A will sort the list A, and A⌹B will solve the system of linear equations Ax=B where A and B are matrices. (This last operation may be unfamiliar, but believe me, it's one that takes a lot of work.) As you may have already surmised, APL is great for working on lists or tables of items, especially if the items are numbers. In fact, APL is much more general: it can handle objects of any number of dimensions, not just lists (which are one-dimensional) and tables (which are two-dimensional).

Mathematicians and engineers love APL for its conciseness and power, but there's quite a price to pay: APL programs are almost unreadable. It's very easy to write a single-line program that would take an average APL programmer a good fifteen minutes to figure out. This is why extensive comments are essential. Typically, good APL programmers write one line of comment for every line of code and try to keep their program lines short. Even so, APL programs are still hard to read, and the language is difficult to learn.

Another problem is that APL is an interpreted language, which means that if you don't use the fancy functions and just write a program using ordinary programming constructs like GOTOs and procedure calls, your program will run slowly.

But that's not the worst of it. APL has a more serious flaw that really concerns the psychology of problem solving. To see the problem with APL, think about how you would find out if a list of numbers has two adjacent numbers that are identical. For example, in the list 4 7 8 9 5 5 7 6, two 5s are next to each other. The first method that comes to my mind (a pretty natural one, I think) is to look across the list of numbers until you find one that is equal to the number to its right. Now you could write that in APL, but you'd have to do so "explicitly," using GOTOs and conditional statements; in other words, you wouldn't be able to use any of the powerful APL operators we were talking about. No self-respecting APL programmer would write the program this way, not only because the program would run slowly, but more importantly because APL programmers seem to feel that they *must* take advantage of the language's fancy features when they develop a program.

So how would you write such a program in APL?

One way to do it is to use the rotate operator to make a copy of the list shifted over by one and then to compare corresponding elements of the two lists for equality. This would produce another list of 1s and 0s (1 for true, 0 for false), and you'd then do what's called an "or-reduction" to produce a 1 if there were two adjacent equal numbers and a 0 otherwise. (Actually, there's a slight bug in this program that occurs when the first number equals the last, but we won't worry about that.) If we call the list of numbers L, the whole program would look like this:

```
v/L = φL
```

Now perhaps you can see the beauty and the terror of APL in one fell swoop: it's a very concise but very odd way of programming.

> Mathematicians and engineers love APL for its conciseness and power. But there's quite a price to pay—a program can be so concise that an experienced programmer would need 15 minutes to decipher a single line.

LISP

LISP is the oldest computer language not considered obsolete by most computer professionals. Other languages invented in the late 50s and early 60s, such as ALGOL, FORTRAN, and COBOL, although still widely used, are no longer considered viable by computer scientists. But LISP is still going strong.

LISP, which stands for LISt Processor, is the language of choice for artificial intelligence research and the brainchild of John McCarthy of Stanford. While at the Massachusetts Institute of Technology in 1960, McCarthy was studying two very different areas: a branch of mathematics called the lambda-calculus and the fairly new programming concept of list processing. The lambda-calculus is a mathematical system dealing solely with functions, and McCarthy drew on some of its ideas to design his programming language, which uses lists as the only data structure. In LISP a *list* is just a group of elements in a particular order, for example:

```
(THIS IS A LIST)
```

This list has four elements, namely the *symbols* THIS, IS, A, and LIST. Lists can also contain other lists:

```
(THIS IS (A LIST WITH THREE ELEMENTS))
```

This list contains three elements, the third of which is a list of five elements. Lists are useful for representing all sorts of things, from members of the board of directors or the first 100 prime numbers to English sentences. But the most interesting things you can represent with LISP lists are LISP programs. For example, here's a LISP program that was designed to find the cube of a number:

```
(DEF CUBE (LAMBDA (N)
    (* N(* NN))))
```

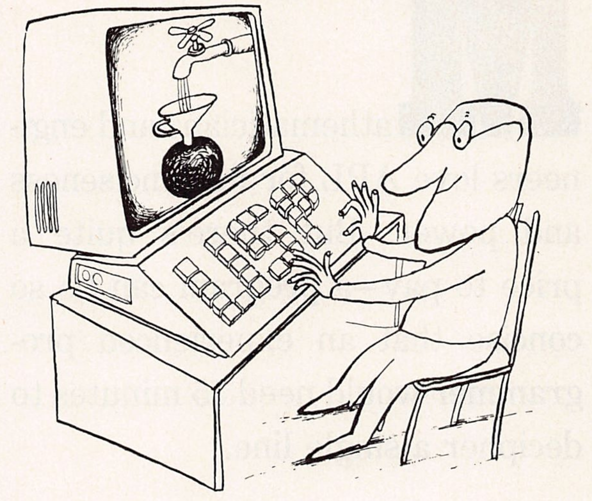
We'll talk about what this means in a second, but first notice that the program is itself nothing but a list! This is one of the most powerful ideas in LISP: programs and data are represented in the same way. This makes it easy to write programs that write and run other programs.

Now let's talk about CUBE. First of all, although I said CUBE is a program, a more accurate term for it would be *function.* A LISP program is nothing more than a collection of functions. In fact, nearly everything in LISP is done with functions, this being the debt LISP owes to the lambda-calculus. In fact, you've probably guessed already that the LAMBDA in the program above is an artifact of LISP's lambda-calculus heritage. The first line of the CUBE function says, "Define a function called CUBE, which takes one argument called N." The LAMBDA merely indicates the beginning of a function. In fact, most modern versions of LISP do away with LAMBDA in this case, using instead the syntax (DEFUN CUBE (N)...) with DEFUN standing for "define function."

Now let's talk about the body of the function. (* N N) signifies "multiply N by itself." It's just as if we'd written N*N in Pascal or BASIC. But in LISP, all functions are written as lists, with the name of the function first, followed by the arguments to the function. (* N (* N N)) just means multiply N by N times N, which of course yields N cubed. Again, most of the more modern versions of LISP would have let us write simply (* N N N), because functions such as * and + can take any number of arguments.

LISP's strange syntax bothers a lot of beginning

LISP



programmers; after all, the BASIC expression

```
B + 3 * C - 4/D
```

becomes a hideous mess of parentheses when translated into LISP:

```
(+ B (-(* 3 C)(/ 4 D)))
```

But once you get over the initial shock, you'll quickly get used to LISP syntax, and text editors designed for editing LISP programs have features that help to keep programs readable. And this notation does have its advantages; for example, while the LISP expression above is unambiguous, you have to know about operator precedence (the fact that multiplication and division are done before addition and subtraction) to get the right answer for the BASIC version. Although you may hear that LISP is hard to learn, it's difficult only if you have to *unlearn* some other language—people who are taught LISP first don't encounter problems.

That's really all there is to LISP: functions operating on lists. So why do most artificial intelligence researchers swear by this language?

The most important reason is that LISP is great for manipulating *symbols*. Workers in artificial intelligence find themselves doing a lot of this sort of manipulation because human thought (which artificial intelligence tries to imitate) involves far more symbol manipulation than number crunching. It's very easy to write a Pascal or BASIC program to add and multiply numbers, but it's much harder to write programs to manipulate symbols that stand for numbers.

For example, when asked to simplify the algebraic expression $x + x + x$, most people would quickly come up with $3x$ (3 times x). Writing a BASIC or Pascal program to do that simplification would be a challenge, but here it is in LISP:

```
(DEFUN SIMPLIFY-ADDITION (EXPRESSION)
 (LIST'*'X(COUNT 'X EXPRESSION)))

(DEFUN COUNT (ATOM LIST)
 (COND
  ((NULL LIST) 0)
  ((EQ ATOM (CAR LIST)) (+ 1(COUNT ATOM(CDR LIST))))
  ((COUNT ATOM (CDR LIST)))))
```

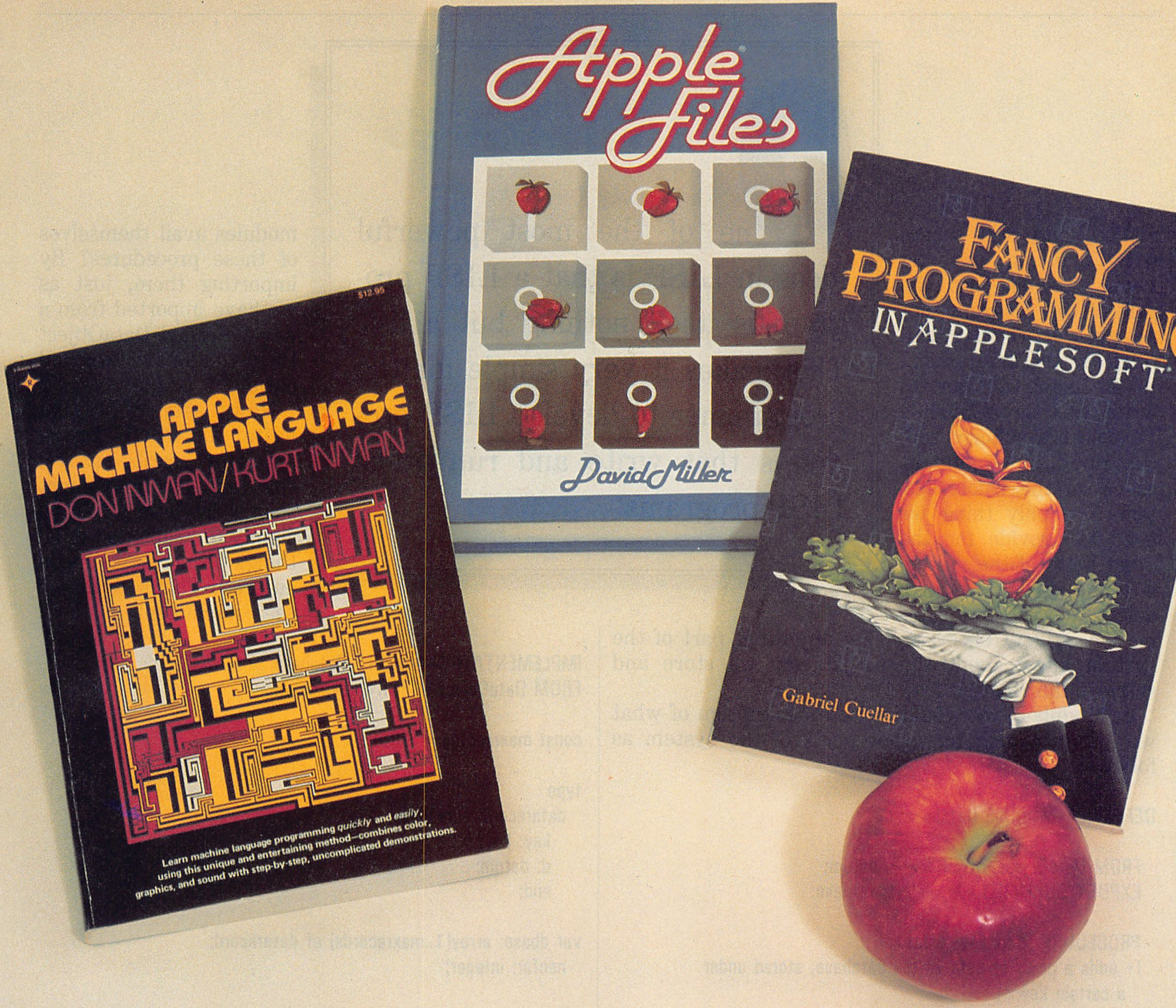
After defining these two functions, saying (SIMPLIFY-ADDITION '(+ XXX)) would produce the result (* X 3). (The COUNT function merely counts the number of *atoms*—individual words—in a given list.) This program could easily be made into a much more general algebraic simplifier. Here again you can see the distinction between program and data being blurred: we're using (+ XXX) as data, but it's also a perfectly valid LISP expression, just as (* N N N) is.

Another powerful feature of LISP is its extensibility. You'll recall from our discussion of FORTH that an extensible language lets you add features that are indistinguishable from the original language. In LISP, user-defined functions like SIMPLIFY-ADDITION and COUNT are written and used in exactly the same way as built-in functions like COND, CAR, and CDR. MIT Professor Joel Moses once described LISP as a ball of mud—no matter how much you add to it, it still looks like a ball of mud.

Modula-2

Pascal programmers will have no trouble recognizing Modula-2—the two languages look almost identical. The likeness is not surprising when you consider that both languages were invented by Niklaus Wirth. But despite superficial similarities, the two are very different, in part because they were developed for different reasons. Pascal was intended to be a teaching language, a task it performs very well. But Pascal has trouble when it comes to writing systems programs—assemblers, compilers, operating systems, and the like. Enter Modula-2, specifically designed for systems programming and built on Wirth's years of experience with languages like ALGOL W, Pascal, and Modula, Modula-2's immediate predecessor.

The major new feature of Modula-2 is the *module*. A module is a collection of type declarations, variables, and procedures. (Users of UCSD Pascal will recognize the module as being very much like a *unit*.) Some modules may be complete programs; others may just provide a group of data and procedures that might be used by other modules. For example, let's say we were programming a large database system. The system would have many parts, some involved with the user interface, others with storing and updating infor-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One of the most powerful ideas in LISP is that a LISP program is itself nothing but a list. This makes it very simple for the programmer to develop LISP programs that write and run other LISP programs.

mation, and still others with printing reports. Let's consider just the part of the program that actually stores and retrieves the information. In Modula-2 we want to write this as a module because it's a fairly self-contained, independent aspect of the whole system. The only thing we need to provide for the other parts of the system is the ability to add, delete, and retrieve information. It isn't necessary that any other part of the system know about the actual way we store and retrieve information.

In Modula-2, we would write a description of what we are providing for other parts of the system as follows:

```
DEFINITION MODULE Database;

  FROM DataObject IMPORT key, datum;
  EXPORT QUALIFIED add, delete, retrieve;

  PROCEDURE add(k:key, d:datum);
  (* adds a piece of data to the database, stored under
    a certain key *)

  PROCEDURE delete(k:key);
  (* deletes the piece of data associated with a certain key *)

  PROCEDURE retrieve(k:key):datum;
  (* finds the piece of data associated with a certain key *)
END Database;
```

This is the *definition* part of the module we're calling Database. It says nothing about how the module actually works; it merely gives a list of the things the module is expected to provide to other modules. The definition says that there is a procedure called "add" that takes as arguments a key and a datum, and we've put in a comment about what this procedure is supposed to do. The procedures for deleting and retrieving a datum are described similarly. But just writing these specifications down is not enough: we must actually make them "visible" to other modules. That's what the line beginning with EXPORT does—it explicitly makes the needed procedures available to other modules. (The word QUALIFIED is required, but I'm not going to discuss what it means here.) How do other modules avail themselves of these procedures? By importing them, just as we have imported from a module called DataObject the definitions for key and datum.

Now it's time to actually write the three procedures we described above. One way to implement such a database would be simply to keep a list of all things that have been entered. That's what we see implemented here:

```
IMPLEMENTATION MODULE Database;
FROM DataObject IMPORT key, datum;

const maxrecords = 1000;

type
  datarecord = record
    key: key;
    d: datum;
    end;

var dbase: array[1..maxrecords] of datarecord;
  nsofar: integer;

procedure add(k:key; d:datum);
begin
  nsofar:=nsofar + 1;
  dbase[nsofar].k:=k;
  dbase[nsofar].d:=d;
end;

procedure delete(k:key);
begin
  ...
end;

procedure retrieve(k:key):datum;
begin
  ...
end;

begin (*initialization*)
  nsofar:=0
END Database;
```

I've omitted the bodies of the delete and retrieve procedures because it's the program's structure we're in-

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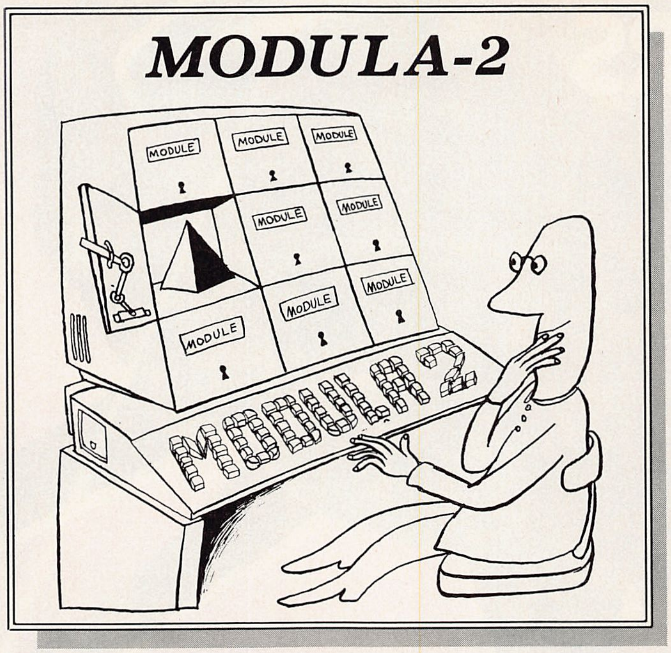


terested in, not the program itself.

You'll note that this is an IMPLEMENTATION module—it contains actual program statements. Also, note that there is no EXPORT statement. That means there's no way for any other module to know about any of the constants, types, or variables I've declared. Other modules can know *only* what they've been told in EXPORT statements.

How does this differ from doing a similar thing in Pascal, namely, defining the same constants, types, variables, and procedures as part of one big Pascal program? The main difference is one of *security*. In the Modula-2 example, it is impossible for any part of the program except the add, delete, and retrieve procedures to get at the actual data in the database. In the Pascal version, nothing would prevent any part of the program from playing around with the contents of the "dbase" array or changing the value of the variable "nsofar." In Modula-2, the structure of the data is hidden; in Pascal, it's available to everyone.

Why would we want to hide some parts of a program from other parts? Isn't this awfully restrictive? Yes, it is restrictive, but years of experience have shown that one of the best ways to write successful programs is to *hide detail*. Everything that anyone could possibly want to do with the database can be done with the procedures in the module we wrote above—no other part of the program needs access to the internal representation of the database, and no other part of the program can possibly get access to it. That's the beauty of Modula-2—when you write programs consisting of groups of modules, you need never worry that one part of your program will accidentally clobber some data in another part. A module is an independent entity that can communicate with the rest of the world only through the data and procedures in IMPORT and EXPORT statements.

Furthermore, we don't have to worry that changing our implementation will introduce bugs into the program. For example, the way I programmed the database above makes it easy to insert something but difficult to delete or retrieve it. If I wanted to make the system more efficient, I would have to rewrite the three procedures, add some variables, take away others, declare new types, and so on. But despite all these changes, I can be confident the program will still work as long as I've made sure that the three procedures still do what I said they would when I wrote the definition module. Because no other part of the program can possibly know about anything in my module except the three procedures, then obviously whatever changes I make can't influence anything else as long as the procedures have the same effects as they did before.

This ability to hide detail is useful for any programming task, but it becomes more useful as the job gets bigger. Large, complex programs have many parts that interact in complicated ways. Sometimes different parts of the program are even written by different people. You can see why it's important to be able to guarantee that certain parts of your module are visible to everyone and other parts are private. Modula-2 provides that guarantee.

Smalltalk

Computer scientists often talk of *computational metaphors*—ways of thinking about programming. The pervasive computational metaphor today is a very simple one: a program is a sequence of instructions that operate on data contained in memory locations. This has proved to be a useful way of thinking about programming for the past three decades, but it's really not a very good metaphor for two reasons. First, it's very much tied to the physical makeup of most modern computers—a single processor executing instructions one by one and tied to a single memory. Second, it isn't very general. The word sequence, for example, doesn't suggest programs that run in *parallel*, with many different computations going on at once. This idea needs to be grafted onto the metaphor.

In 1969, a University of Utah graduate student named Alan Kay came up with a different computational metaphor. Why not, he asked, view all computation as the sending of messages between objects? Instead of seeing 5 + 3 as "run the sequence of instructions for addition, using 5 and 3 as data," think of it as sending a message to the object 5 asking it to add itself to 3. This idea says nothing about the physical structure of the computer being used, it's much more general than the instruction-data metaphor, and

The beauty of Modula-2 is that you can write programs that consist of groups of independent modules. This means you'll never need to worry that one part of your program will accidentally clobber data in another part.

nothing in it prevents many objects from sending many messages all at once.

Kay's ideas provided the basis for Smalltalk, a language developed over a ten-year period at Xerox and only recently revealed fully to the public. Smalltalk is an *object-oriented* language, which means that it subscribes to Alan Kay's metaphor in which everything is an object and objects communicate by sending messages to one another.

Smalltalk particularly shines when the task fits naturally into the object-message metaphor. An adventure game is a good example of such a program. As you probably know, an adventure game involves exploring a cave, castle, or some other domain, looking for treasure, and (usually) killing monsters. If we wanted to program such a game in Smalltalk, we'd first think about what sort of objects are involved. Well, there's the adventurer (representing the player); there are the rooms of the cave, the different monsters, the treasures, and assorted objects like weapons and food. As you can see, objects fall naturally into *classes*. In Smalltalk, every object belongs to some class. An object is called an *instance* of its class. Here's a description (called a *class template* in Smalltalk jargon) of the Monster class:

```
class name: Monster
superclass: AdventureObject
instance variable names: location, strength, damage
methods:

location ||
↑ location

attack: anAdventurer ||
anAdventurer hitWith: strength

hitWith: aWeapon ||
(aWeapon = 'sword') ifTrue: [damage ← damage - 10]
ifFalse: [(aWeapon = 'dagger') ifTrue: [damage ← damage - 2].]
"if it's not a sword or dagger, it can't hurt us"

dead? ||
↑ (damage = 0)
```

The *superclass* of a class, as the name suggests, is the class it belongs to. Smalltalk classes are in this way hierarchically ordered. (We'll see this in more detail later.) We've said that Monster is a subclass of AdventureObject, a class we won't show here.

The instance variables of a class are the pieces of information that instances of that class can possess. For example, every monster in our game will have some location, some strength, and may have had some damage done to it.

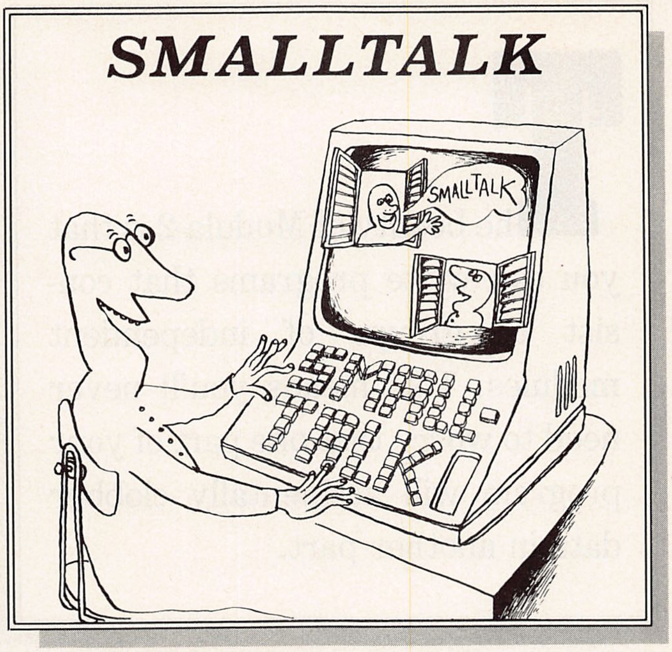
For every class we create, we have to specify how instances of that class will react when they receive messages. The list of instructions we write to describe reactions to a message is called the *method* for that message. We've written messages that let other objects examine the location of a monster, tell the monster to attack an adventurer, inform the monster that it has been hit with a certain kind of weapon, and so on. Note that there's no way for any object to find out directly what the strength of a monster is or how much damage has been inflicted on it because there are no methods that provide this information. This is the same concept of hiding information that we discussed when talking about Modula-2. In fact, you may notice that an object is in many ways like a module: it's a collection of data (instance variables) and procedures (methods) with only those parts showing that the programmer wants to be visible.

Smalltalk, in addition to providing the elegant message-passing metaphor, also has a very powerful concept called *inheritance*, which is best explained by another example. Here's the class template for Goblin:

```
class name: Goblin
superclass: Monster
instance variable names: invisible?
methods:

attack: anAdventurer ||
"become visible, attack, become invisible"
self appear.
super attack: anAdventurer.
self disappear.

hitWith: aWeapon ||
"can't hit me if I'm invisible"
invisible? ifFalse: [super hitWith: aWeapon].
```



```
appear ||
invisible? ← False

disappear ||
invisible? ← True
```

Note that the superclass of Goblin is Monster. This means that Goblin *inherits* any methods and instance variables of Monster. For example, all goblins will have a location instance variable and use the same location method that we wrote for the Monster class. But goblins have the special ability, shared by no other kind of monster, to become invisible. So in addition to what it has inherited from Monster, we define for Goblin a new instance variable that will record whether the goblin is visible and define some new methods to alter the variable. We also redefine some of the methods inherited from Monster because we want goblins to react differently to these messages than other monsters do. If we ever want our superclass to handle the message, we can just use the special name super as if it were an object and send the message directly to it.

This all sounds complicated, but perhaps we can simplify it by summarizing the essential points: classes inherit the attributes of their superclasses and can add to or change what they've inherited. That's a very powerful idea—it helps to gather commonalities in one place so they needn't be duplicated and allows the programmer to delegate some jobs to classes that have already been written.

All these features of the Smalltalk language are very important, but they're only half the story. The designers of Smalltalk realized that the *environment* in which you program is just as important as the language itself, so they put a lot of effort into constructing a powerful software development system. Indeed, the Smalltalk environment is regarded as the state of the art. Its first key aspect is that, like FORTH, it's integrated. In other words, all the different parts of Smalltalk—the text editor, the file system, even the compiler—are written in Smalltalk and are available to the user for inspection or change. The second important aspect of the environment is its user interface, which is window-oriented. In typical systems, you have to leave the program you're working on and start up another when you want to switch tasks. In Smalltalk, each of the things you're working on is contained in a rectangular window on the screen. For example, one window might contain a report you're writing, another might have the output of a program, and so on. To switch what you're doing, you simply select the window you want, typically using a pointing device like a mouse. This is a very convenient way of working because you can see at the same time all the different tasks you're involved with represented on the screen as a group of overlapping windows, and you can easily switch between tasks in a matter of just a few seconds. If you've been reading about Apple's Lisa computer, you'll see that the Smalltalk interface is very similar to Lisa's. Actually, it was Lisa that borrowed its ideas from Smalltalk.

Smalltalk was originally designed for children, but as you can see from the examples here, it has grown into a far more complicated programming language. Still, the pleasant user interface and the pervasive message-passing metaphor make it easy to learn, but it's powerful enough to be a possible rival to LISP in the artificial intelligence community.

PROLOG

PROLOG is a fairly new language. Invented around 1970 by Alain Colmerauer, it's just beginning to be recognized by the academic community as a useful language for artificial intelligence, a domain formerly held only by LISP. Part of the reason for the interest is that the Japanese have chosen PROLOG to be the standard language for their fifth-generation computer project, an ambitious ten-year plan that, if it succeeds even partially, will make Japan the new world leader in advanced computer applications and expert systems. If the project succeeds, we'll all be programming in PROLOG by 1995.

Like LISP, PROLOG has a mathematical foundation. LISP, you'll recall, is based on the lambda-calculus; PROLOG is based on logic. In fact, PROLOG is short for PROgramming in LOGic. As an example of how PROLOG works, let's consider the famous syllogism:

```
Socrates is a man.
All men are mortal.
Therefore, Socrates is mortal.
```

The first two statements are nothing more than

The designers of Smalltalk put a lot of effort into constructing a powerful, state-of-the-art software development system, and Apple Computer Inc. has borrowed this radically different environment for its new Lisa computer.

facts or *assertions*. The third statement, as its first word suggests, is the conclusion we can draw from those assertions. Here are the first two statements written in PROLOG, with "man" changed to "human" to avoid accusations of sexism and to make the example a little more general (after all, women are mortal too):

```
human(socrates).
mortal(Something):-human(Something).
```

The first line of PROLOG corresponds exactly to the first line of English: in this statement we are simply *asserting* that Socrates is human. In PROLOG, it's most common to write the attribute of an object first, then the object itself in parentheses. You'll notice that we didn't capitalize Socrates. That's because socrates is a *constant*—that particular combination of letters always refers to the same unique individual. PROLOG uses names that start with capital letters only to indicate variables, as we'll see when we look at the next line.

The second statement also corresponds exactly to its English counterpart, although that's a little harder to see at first. One way to read this line is: "Something is mortal *if* that same something is human," or to put it in slightly more mathematical terms, "That something is mortal is *implied by* the fact that that thing is human." What this particular statement is saying to PROLOG is: "If you're trying to show that a particular thing is mortal, you can do that by showing that it's human." PROLOG statements of this form are called *rules*.

As you probably have already guessed, the word Something in the second PROLOG statement is a variable. It doesn't refer to any specific thing, although PROLOG may give it a *value* at certain times. Any PROLOG word that starts with a capital letter is a variable.

Now we'll assume that PROLOG "knows" the two facts we have programmed above. Let's see what happens when we ask it:

```
mortal(Who)
```

Here we are asking PROLOG, "Who is mortal?" Notice that Who is a variable. PROLOG will look through its list of statements for something that starts with mortal. Sure enough, it finds our second statement, which tells it that if it wants to find mortal things, it should look for human things. PROLOG then searches its list again and finds that socrates is human, which tells it that socrates is mortal. It will then print on the screen the following result:

```
Who = socrates
```

This shows that the variable Who that we mentioned in our question has the value socrates; in other words, Socrates is mortal.

Perhaps you can see from this simple example how powerful PROLOG can be. We can, of course, make much more complicated rules and ask much more difficult questions. For example, if we defined the rules for addition correctly and then asked

```
plus(3,4,X)
```

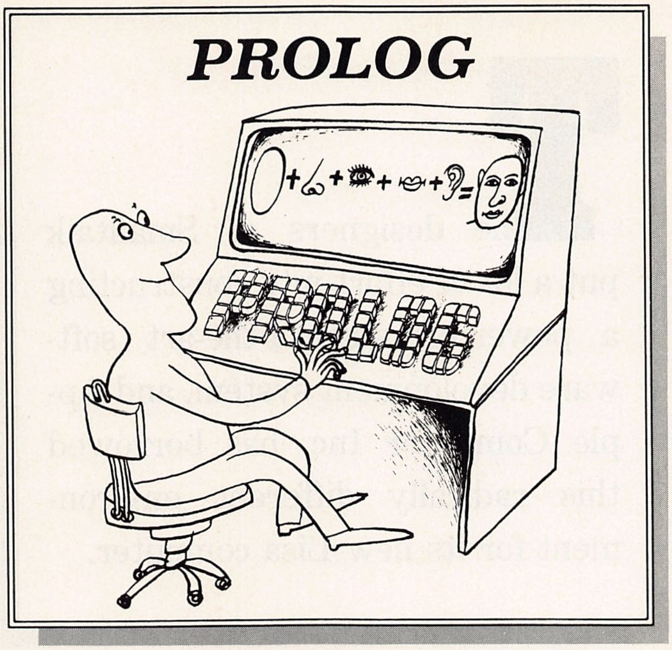
(meaning "What is 3+4?"), PROLOG will respond "X=7." But we could, in theory at least, ask

```
plus(X,Y,7)
```

in which case PROLOG should tell us all pairs of numbers that add up to 7.

As you can see, programming in logic can be a pretty powerful tool. But PROLOG has its problems. For one, the language couldn't possibly answer "plus(X,Y,7)" correctly because there are infinite answers! So even though PROLOG fans say you can program in logic, you have to keep in mind that, as the boy in *E.T.* said, this is reality. PROLOG was designed to run on an ordinary computer, not on a magical logic machine—it's only an approximation of logic, and sometimes its approximations can be pretty strange. For example, the order in which you enter rules and assertions can change the answers you get. Once you get the hang of it, these quirks are somewhat bearable, but they do make the language difficult to learn.

Another problem with PROLOG is its rigid control mechanism. The language is touted as *nonprocedural*



because a programmer doesn't have to write an exact procedure to solve something; the programmer has only to describe the problem and PROLOG will do the rest. But of course PROLOG has its own built-in way of solving problems, and you sometimes have to put up a bit of a fight if you want to do things differently.

I'll mention one final, rather esoteric but very serious problem with PROLOG. Quite a bit of discussion during the last few years, mostly in artificial intelligence circles, has explored just how good logic itself is for solving many of the sorts of real-world problems that artificial intelligence researchers explore. For example, in ordinary logic (the kind PROLOG is based on), there's no way to say "I don't know." Anything that can't be proven true is considered false. This makes it difficult, for example, to talk about events in the future whose outcome is unknown.

As I said, the Japanese have adopted PROLOG, but they're not insensible to its faults. They're working hard to fix the problems while retaining the power. In less than a decade, we'll see how well they've done.

Conclusion

A conclusion is a place for opinions, and I won't hesitate to give mine (with the warning that my training and interests lie more in the areas of computer education and artificial intelligence than in business, engineering, or systems computing).

It can be demonstrated mathematically that any

For More Information

FORTH

The August 1980 issue of BYTE magazine has several good articles on FORTH. A recommended book is Leo Brodie's *Starting FORTH* (Englewood Cliffs, NJ: Prentice-Hall, 1982). The FORTH International Standards Team designs FORTH standards. Current standards are from 1979.

Implementations for Microcomputers

If you're interested in obtaining the language itself, you should contact the FORTH Interest Group, POB 1105, San Carlos, CA 94070. For $15, you can buy a listing of FORTH for virtually any microcomputer on the market. The group also publishes the journal *FORTH Dimensions*. Other versions are available from:

- FORTH Inc., 2309 Pacific Coast Highway, Hermosa Beach, CA 90245

- Laboratory Microsystems, 4147 Beethoven St., Los Angeles, CA 90066 (for CP/M and CP/M-86 operating systems)

- Miller Microcomputer Services, 61 Lake Shore Rd., Natick, MA 01760 (for TRS-80 and IBM Personal Computer)

- Mountain View Press Inc., POB 4656, Mountain View, CA 94040 (for Apple II, Atari, Commodore, IBM, and TRS-80)

- Unified Software Systems, POB 2644, New Carrollton, MD 20784

APL

The original work on APL is K. E. Iverson's *A Programming Language* (New York: John Wiley and Sons, 1962). I'm not aware of any APL standards.

Implementations for Microcomputers
- Softronics APL (Softronics, 36 Homestead Ln., Roosevelt, NJ 08555) for the CP/M operating system

- TIS-APL (Telecompute Integrated Systems Inc., 251 Spadina Ave., Toronto, Ont., Canada M5T 2E2) for the Altos ACS 8000, the TRS-80 Model II, and other Z80-based microcomputers

- Waterloo Micro-APL (Waterloo Computing Sys-computer language can simulate any other. So in terms of the problems they can solve, all computer languages are equivalent. Of course, some languages make it much easier to express certain problems while other languages let you write more efficient programs. But what I feel to be most important in a computer language is the computational metaphor on which it is based. Programming languages, like natural languages, influence the way we think about the world. Languages that offer archaic ways of thinking—languages like FORTRAN, COBOL, BASIC, Pascal, FORTH, and even Modula-2—have the upper hand now. But metaphors like APL's vector-based mathematics, LISP's functions, Smalltalk's objects, and PROLOG's logic are so powerful and compelling that they are sure to dominate as soon as enough people have had the chance to experiment with them.

Unfortunately, more metaphorical power requires more computing power, so few of the languages we've looked at here can be implemented efficiently enough on today's microcomputers to make them practical. But a new generation of microcomputers with more power and memory than ever before has already begun with the introduction of Apple's Lisa. These new machines *will* be able to support languages like Smalltalk and PROLOG. That's when we'll see if programmers, unlike typists, will be able to free themselves from the QWERTY syndrome. □

Japanese researchers have chosen PROLOG as the standard language for their fifth-generation computer project. If the project succeeds, it's very likely that we'll all be programming in PROLOG by 1995!

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tems Ltd., 158 University Ave. W, Waterloo, Ont., Canada N2L 3E9) for the IBM Personal Computer

LISP

The two best books on LISP are *LISP*, by Patrick Winston and Berthold K. Horn (Reading, MA: Addison-Wesley, 1981), and *Artificial Intelligence*, by Patrick Winston (Addison-Wesley, 1977). A rather interesting, short, but probably hard-to-find book is *The Little LISPer*, by Daniel Friedman (Palo Alto, CA: Science Research Associates, 1974). Also, the August 1979 issue of BYTE is devoted to the language. There is no official LISP standard, but work is currently under way on Common LISP, which may become a de facto standard.

Implementations for Microcomputers

- LISP Interpreter (PCD Systems, POB 143, Penn Yan, NY 14527) for the UCSD p-System
- Supersoft (POB 1628, Champaign, IL 61820) for the IBM Personal Computer

Modula-2

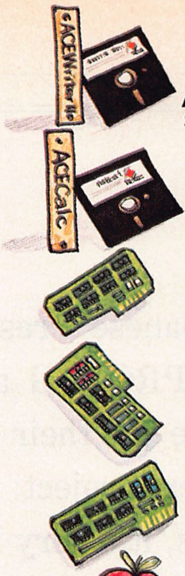
Modula-2 is so new that I am aware of only one reference: Niklaus Wirth's *Programming in Modula-2* (New York: Springer-Verlag, 1982). As far as I know, at this time there are no microcomputer implementations, although as the language is not much more difficult to implement than Pascal, we should see microcomputer versions soon. No official standard exists, but Wirth's book makes some strong suggestions.

Smalltalk

Addison-Wesley is coming out with two books on Smalltalk written by researchers at Xerox's Palo Alto Research Center: *Smalltalk-80: The Language and Its Implementations* and *Smalltalk-80: The Interactive Programming Environment* (both should be available this year). These will become the only standard for the language. Also, the August 1981 issue of BYTE is devoted to Smalltalk. A potential implementation on Apple's Lisa is the only microcomputer version I've heard of.

PROLOG

Programming in PROLOG, by W. F. Clocksin and C. S. Mellish (New York: Springer-Verlag, 1981), is the only book on PROLOG that I'm aware of. Although there is no PROLOG standard, there is Micro-PROLOG for Z80-based systems from Logic Programming Associates Ltd., 10 Bertwood Close, London SW18, England.



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A Great Way To Sharpen Your Thinking

Why You Should Learn To Program

BY CHRIS CRAWFORD

I am not a programmer. Although I do write programs professionally and have written a number of successful programs, I do not consider myself a "real" programmer. Programming is not my primary avocation and never has been. What's more, I have never taken a single programming course.

I say these things because I want to discredit the common misconception that programming is some special black magic accessible only to the high practitioners, the "real" programmers. We commonly associate programming with programmers in the same way that we associate neurosurgery with neurosurgeons, nuclear physics with nuclear physicists, or flying the space shuttle with astronauts. Each of these three professions is immensely difficult, demanding long and careful training. Those who master such jobs merit our respect—perhaps even our awe. Moreover, there are no halfway states in any of these three fields: either you make it or you fail. We don't have amateur neurosurgeons, nuclear hobbyists, or do-it-yourself space-shuttle pilots.

But programmers do *not* belong in this Awesome Calling category, even though some programmers enjoy being mistakenly lumped in that group just the same. After all, it enhances their public esteem as well as their paychecks. Programmers rely on a number of social mechanisms to preserve the mystique of their craft. The most obvious of these is their jargon. Every special group of people creates its own special subset of the language; it's a normal means for establishing a group identity. But of all the groups I've encountered, programmers have the most singular lingo. The jargon of programming goes far beyond the reasonable need for handy terms that concisely describe concepts unique to the group. Much of the jargon of programming and computers exists only to intimidate and exclude nontechnical people.

Another technique programmers use to intimidate nontechnical folks is an exaggerated sense of taste and discernment. Tell a professional programmer that you like BASIC, then prepare yourself for a torrent of abuse. BASIC, he or she will tell you, is not merely a weak language, or a slow language, or an unstructured language; no, it is an execrable language, a *trashy* language. Only peasants use BASIC. You'll get similar reactions if you discuss almost anything else about computers. Hardware? Brand X is glorious; everything else is rank trash undeserving of the name "computer." Operating systems? Anybody who doesn't use XXX operating system is a simpleton.

Chris Crawford is manager of games research at Atari Corporate Research in Sunnyvale, California.

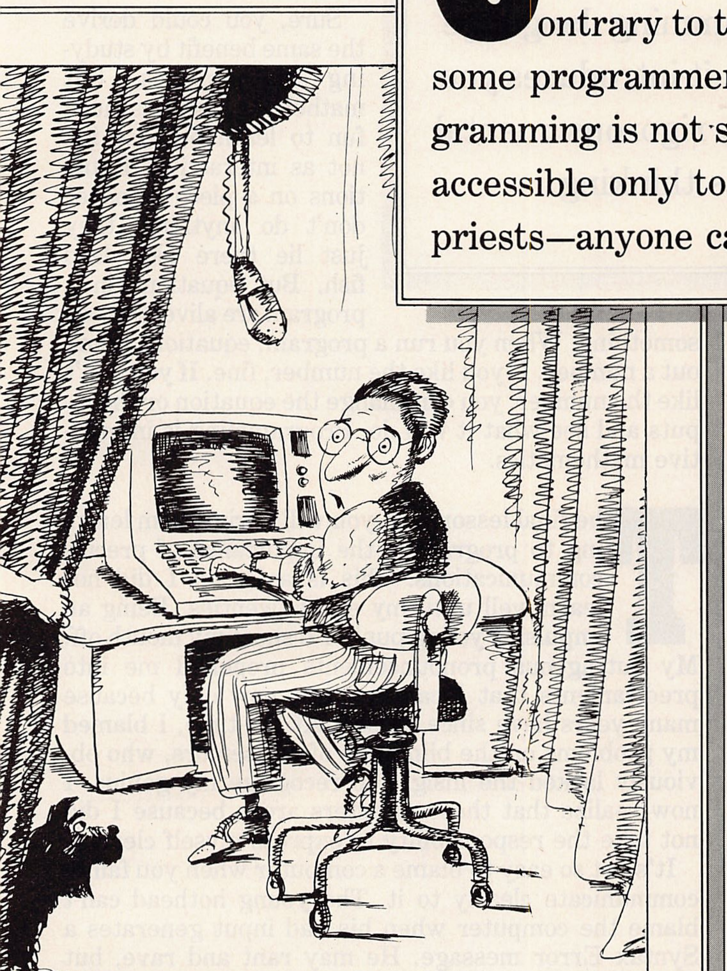
Guess where all this puts you, the nonprofessional? You haven't even heard of this wonderful operating system or that fabulous piece of hardware. If only simpletons and perverts use other products, you must be an even *lower* creature not to be aware of them. Perhaps you'd better slink off before you're exposed for the presumptuous fraud you are. Leave programming to the experts who know what they're doing. Right?

Wrong! Programming is not like neurosurgery, nuclear physics, or flying the space shuttle. Programming is like writing, woodworking, or photography. Anybody can do it. Doing it well, doing it like an expert—that takes a lot of work, a lot of experience, and a lot of talent. But anybody who can write a comprehensible paragraph can write a workable program. All it takes is a tiny amount of intelligence (a *very* tiny amount of intelligence), a computer to practice with, and some time.

The real question you should ask yourself, then, is not whether you have the ability to learn to program, but whether you should bother to learn to program. Naturally, I'm rather prejudiced: I think that everybody should learn to program, and I have four good reasons for you to consider.

Before I start, though, I want to refute the propaganda that gets most people interested in programming. I'm sure you've heard this refrain: "You'd better learn to program because computers are the coming thing, and if you don't know how to program them, you'll be left out in the cold." I reject this argument because it's based on some rather naive assumptions about the relationships between people and technology. Specifically, this reasoning assumes that technology dictates the shape of society, regardless of the values of people. The fact is computers will be changed a lot more by people than people will be changed by computers. After all, humans pay the piper, and humans call the tune. Computers *are* coming and they will change society, but when they arrive in force they'll be much easier to operate. If the computers of the future demand as much skill to operate as, say, private airplanes, then they probably won't be much more numerous than private airplanes. If they are as easy to operate as cars, they will be more numerous. Therefore, don't learn to program out of fear that you'll become obsolete in the brave new world of computers. There are much better reasons for learning to program. All of them concern how computers can help you become a better person.

> Contrary to the mystique that some programmers cultivate, programming is not some black magic accessible only to wizards or high priests—anyone can do it.



The first good reason for learning to program is recreation—and I'm not talking about computer games. Computer games are recreational, but you don't need to learn to program to get more out of them. No, I think you can derive much enjoyment from writing your own computer game or perhaps some other program. Don't write a program to get rich on royalties; the Horatio Alger days of luck and pluck in software are over now. There's plenty of competition, and the only way to get rich is through hard work, talent, and experience, all in large measures.

Instead, write a program for the sheer joy of it. Consider, for example, one of the most common hobbyist activities: writing blackjack programs. Lots of beginning programmers do it, and if it suits your fancy, you should too. Now don't kid yourself. Your blackjack program won't be anywhere near as good as the slick, professional package you can buy in a computer store. But it will be *your* blackjack program, with your own personal touch, and that's what makes it better than the professional product. Every year, people spend millions of dollars taking crummy snapshots of the Grand Canyon, Niagara Falls, and the Golden Gate Bridge when they could buy professional-quality photographs for less money. Why? Because they enjoy and value their own creative efforts, however flawed, more than the impersonal perfection of the professional. People make their own furniture, paint, weave rugs, and so on. They may not save any money, but they have a lot of fun doing it. Programming as a creative outlet can be just as rewarding.

The other three reasons for learning to program all involve the educational value of learning to program. I emphasize educational value as opposed to training value. Education focuses on ideas and principles, while training focuses on skills. Learning to program will leave you with a particular skill—the ability to write a program—but I don't think that skill is very important to most people. What is important is the way that the learning experience will change the way you think.

The second reason for learning to program is that it will introduce you to the concept of logical thinking. When I was 14 years old, I studied Latin. At the time, I didn't understand why I was wasting time studying a dead language. What good would it do me? I asked. My Jesuit teachers, wise, patient, and understanding, told me to shut up and study. Although I hated it at the time, I now know that studying Latin was one of the most productive things I did in high school. It taught me to think logically. Latin is a closed, logical system with a consistent set of rules governing its behavior. By studying Latin, I learned that it is possible, once you have learned the principles, to navigate your course through a complex system solely by careful thinking. This is an exhilarating realization for a confused kid.

Illustration by Keith Bendis

A programming language is a lot like Latin: it introduces you to a disciplined, rigorous mental activity known as thinking.

I suggest that a computer language is just like the Latin tongue. Like Latin, a computer language is a closed, formal, logical structure for communicating. Like Latin, it has a careful but limited syntax that must be obeyed. Like Latin, it can introduce a person to the disciplined, rigorous mental activity known as thinking. Yet a computer language is better than Latin, for while Latin is learned by reading, programming is learned by doing.

The third reason to learn to program is that it will sharpen your thinking, even if you have already learned the fundamentals of clear thinking. I once had a crusty, demanding old English teacher who hectored me endlessly about my writing. He would make fun of me by deliberately misinterpreting my sloppy compositions in the most embarrassing manner possible. I would protest, "That isn't what I meant. I know what I meant to say. I just didn't say it very well." To which he would retort: "If you can't say it, you don't know it." That English teacher was as right as anyone can ever be. The act of expressing a thought is not some minor function to be handled after the thinking is done; it is part and parcel of the thinking itself.

Unfortunately, the spoken languages we use aren't very good for expressing complex scientific and mathematical relationships. Consider, say, the English explanation of Newton's law of gravitation:

"The gravitational force between two point objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between them."

Sounds pretty imposing, doesn't it? Yet the idea is actually fairly simple and is compactly expressed in mathematical notation:

$$F = \frac{GM_1M_2}{R^2}$$

The idea is also compactly expressed in computer languages, as this BASIC statement shows:

```
F=G*M1*M2/R**2
```

A computer language enables you to express ideas that are too clumsy to express clearly in English. And as you learn to express them, you learn to think about them more easily. If thinking is like a journey through intellectual territory and language is a vehicle for such travel, then English is like a car and BASIC is like a boat; each lets you explore a different terrain.

Sure, you could derive the same benefit by studying mathematics, but mathematics isn't as much fun to learn because it's not as interactive. Equations on a piece of paper don't do anything; they just lie there like dead fish. But equations in a program are alive; they *do* something. When you run a program, equations crank out a number. If you like the number, fine. If you don't like the number, you can change the equation or the inputs and see what it will do. Programming is interactive mathematics.

The final lesson that you will derive from learning to program is the importance of precise communications. This is a lesson I did not learn well until my early twenties. Being an impulsive young punk, I'd shoot my mouth off. My outrageous pronouncements propelled me into predicaments that I can laugh at now only because many years have since passed. At the time, I blamed my problems on the blindness of my seniors, who obviously lacked the insight to recognize my genius. I now realize that these disasters arose because I did not take the responsibility to express myself clearly.

It's not so easy to blame a computer when you fail to communicate clearly to it. The young hothead can't blame the computer when his bad input generates a Syntax Error message. He may rant and rave, but deep down inside he has to admit that the computer is not out to get him or always trying to trip him up. When the temper tantrum ends, he sits down and mutters, "Well, let's figure out what I have to say to make this thing do what I want." The wonderful thing is the computer will respond eventually. If the hothead gets his inputs right, the computer will do whatever he wants it to do. The lesson learned from this experience is important because people are the same way—they will do almost anything for you, but you've got to make the effort to communicate clearly.

Programming is a never-too-late type of experience. My first contact with computers came at age 18, and my most active learning period came at age 27. By that time I had earned a master's degree in physics and was already a skilled thinker. Even so, learning to program sharpened my reasoning powers considerably. You should do it too—without further procrastination. It will do more for you than all the computer games and spreadsheets and word processors in the world. It will make you a better thinker. ☐

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Radio Shack's PC-4

It may mark the beginning of the end of programmable calculators

by Dennis R. Allen

A few years back, programmable calculators were the rage. Students, engineers, and scientists marveled at these shirt-pocket-sized gadgets that they could program to handle their most complex calculations.

During the fall of 1981, Radio Shack came out with the PC-1 (see *Popular Computing*, March 1982, page 38), a pocket computer that offered several advantages over programmable calculators. The PC-1 was much easier to program because it used the easy-to-understand BASIC language and could handle alphanumeric, instead of just numeric, information. Even so, largely because the PC-1's price tag was around $250 at the time (it last sold for $99), the decline of the programmable calculator's popularity was slight.

Enter Radio Shack's newest contestant in the pocket computer market, the PC-4. The $70 replacement for the PC-1 is a smaller yet faster and more powerful pocket computer than the PC-1. The 4.1-ounce shirt-pocket-sized machine is not only a handy tool for those who want to learn BASIC programming, but it's powerful enough to make quick work of tough applications in the classroom, the office, and the lab as well as remote areas. In short, because of its ease of use, battery power, ability to expand, and low price, the PC-4 and machines similar to it—like the Casio FX-700P and the Sharp PC-1250—may indeed signal the beginning of the end of programmable calculators. Incidentally, Radio Shack has not as yet introduced a PC-3 pocket computer, and the company's PC-2 (see March 1983, page 67) is a more powerful big brother of the PC-4.

Radio Shack

The PC-4 Pocket Computer with cassette interface and printer.

Taking a Closer Look

The PC-4 features a 12-character liquid-crystal display (LCD)—half the size of the PC-1's display. Yet the smaller LCD presented no problem when I ran a program because the PC-4 scrolls horizontally, even during program execution, to display a line or message longer than 12 characters. The PC-1, on the other hand, scrolls horizontally only when you're writing a program, which means that it displays only the first 24 characters of an answer or message during program execution.

Because we live in a world that is mesmerized by bells and whistles, I was not surprised to find a new feature, a contrast adjustment for the LCD, on the PC-4. But a few minutes after I began using the little gizmo, I conceded that the contrast adjustment was more than just a gimmick. Often, the characters on an LCD are difficult to distinguish when you look at them from certain angles. The PC-4's contrast dial, located on the right side toward the rear of the unit, proved to be an asset, for by adjusting the contrast, I could read the display from several different angles.

The LCD shows in small letters at the top of the display the abbreviation of which of the 10 modes the computer is operating in. You select a mode by pressing the mode

Dennis R. Allen is a freelance writer living in League City, Texas.

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At a Glance

Name: TRS-80 Pocket Computer Model PC-4

Uses
Personal computing for scientific, business, and school applications

Manufacturer
Radio Shack
1800 One Tandy Center
Fort Worth, TX 76102
(817) 390-3011

Standard Features
Custom CMOS VLSI; 53-key multimode keyboard, which includes upper- and lowercase letters and a 10-key numeric pad; less than 1K bytes of RAM (544 program steps with 26 variables); 1K-byte RAM module available for memory expansion; 12-character alphanumeric LCD with contrast adjustment; BASIC language stored in read-only memory

Base List Price
$69.95

Typical System Price
PC-4, cassette interface, cassette recorder, printer: $259.80

Documentation
66-page owners manual; 195-page *PC-4 Programming Guide*

Popular Options and Accessories

Cassette interface	$39.95
Minisette-9 cassette recorder	69.95
PC-4 Printer	79.95
Memory expansion (1K bytes)	19.95
Carrying case	7.95

key and the appropriate numeric key. The run and write modes are used to execute and enter a program, and the trace mode stops a program at each line to make debugging easier. The print mode sends output to the printer, if connected. The PC-4 has three angular modes: radian, degree, and gradient. The extension mode lets you enter lowercase letters; if you use the shift key, a set of 26 special characters (each key is labeled) becomes available. The special character set contains only five graphics characters: the four playing-card symbols and a filled-in square. The remaining characters include scientific symbols—such as quadrature, trine, sum, and degree—and other niceties such as brackets and an ampersand.

The numeric keys also give you access to specific programs. You can store as many as 10 short programs in the computer at one time and select a program by using the shift key and the appropriate number. The size of an individual program can vary. The standard PC-4 can hold a single program up to 544 program steps long or several programs with a combined total up to 544 program steps (less than 1K bytes).

Other special keys include deletion and insertion during editing, cursor movement, a key to recall the previous answer in manual calculations, comparisons (≠, ≤, ≥), exponent, and pi, which enters the number 3.14592654.

The PC-4 is powered by two lithium batteries that provide about 360 hours of continuous use. But don't think that you might drain the batteries by accidentally leaving the PC-4 turned on for 15 days straight. Unless a program is running, the computer shuts itself off to conserve energy after remaining dormant for seven minutes. There's no need to panic, though—the memory is not lost and returns when you switch the computer back on.

Expandability

In the computer business, expandability is the name of the game, and the PC-4 is playing its options. A 12-pin connector in the rear of the unit enables you to add a cassette interface and a printer, and internal connections let you install a random-access-memory (RAM) module.

Radio Shack markets an inexpensive ($19.95) 1K-byte RAM module for the PC-4. Installation of the module requires removing the PC-4's rear panel and is much like changing batteries. Once installed, the RAM module expands the PC-4's standard 544 program steps to 1568 steps, about three times the original memory size. With either memory size, the computer automatically sets aside enough memory for 26 variables, although you can increase the number of variables with a simple command. To get more variables, you make a trade-off in memory—the number of available program steps decreases by eight for every variable added. For example, if you change the number of variables to 50 (an increase of 24), the number of available programming steps is decreased by 192 (8 × 24 = 192), thereby leaving a standard PC-4 with 352 programming steps and an expanded model with 1376.

A cassette interface plugs into the multipin connector so you can use a cassette recorder to store and retrieve programs and data. The interface is lightweight (8½ ounces) and operates on two AA batteries. The data transfer rate, 300 bits per second, is not fast: one program that I entered used only 258 steps and took a little more than 40 seconds to store. The slow rate, however, shouldn't be a problem. The PC-4 can store as many as 10 separate programs in memory, and you can selectively load or save programs individually. This avoids the need to transfer the entire memory contents and, therefore, keeps you from hopelessly staring at a busy computer and waiting, and waiting, and waiting. Even with the optional RAM pack, the memory is less than 2K bytes, and a program that fills the memory capacity will take no more than a few minutes to transfer. The VER (verify) command checks to see that data has been properly recorded, but it does not make a byte-for-byte comparison. Thus, it is possible for *verified* data to be wrong.

Another add-on peripheral is the PC-4 Printer, which plugs into the rear of the cassette interface in a piggyback manner. Together, the cassette interface and printer look and operate like a single unit. The PC-4 Printer is powered by rechargeable nickel-cadmium batteries and comes with its own AC adapter/charger. Unlike the PC-1

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Printer, the PC-4 Printer uses an electrothermal print head to form 5 by 7 dot-matrix characters and prints 20 characters per line (4 more than the PC-1 does). The speed, however, is about the same: 60 lines per minute.

PC-4 BASIC

Programming is a snap on the PC-4 because 16 of the most frequently used BASIC statements can be entered with one key while you're in the shift mode. This method differs from the one that the PC-1 uses. (On the PC-1, a statement might require three or more keys for its abbreviation, which, of course, you must memorize.)

Program lines can be up to 62 characters long, and the cursor changes its shape after you enter 55 characters to let you know you are running out of space. PC-4 BASIC is similar to, though not 100 percent compatible with, PC-1 BASIC, but it does offer a few additional commands and functions.

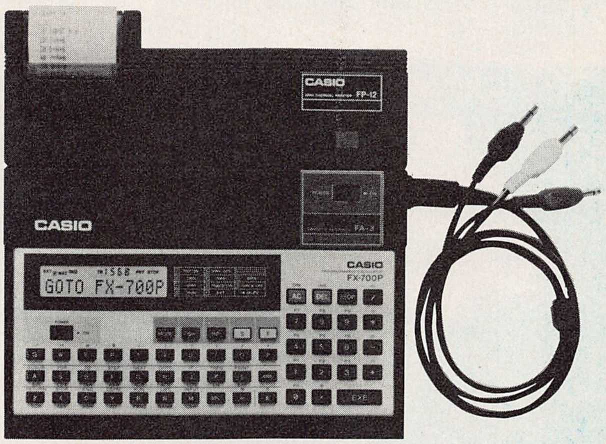
The KEY statement, much like INKEY$ on larger computers, instructs the computer to read a character typed in while a program is running. The CSR statement lets you print a character at a specified position on the LCD, like the PRINT @ command on a TRS-80 Model III. Numeric formatting, which lets you designate the number of decimal places to print or display on the LCD, is also available.

PC-4 BASIC supports alphanumeric strings up to 30 characters long. You manipulate a string with three common BASIC functions: LEN, MID, and VAL.

Two particularly useful functions of PC-4 BASIC are FRAC (deletion of integer), which returns only the decimal portion of a number, and RND, which rounds off a number at a specified position. Also included is a random-number generator, RAN#, which returns random numbers between 0 and 1.

Seeing Double

Casio Inc. (15 Gardner Rd., Fairfield, NJ 07006, (201) 575-7400) offers a similar computer, the FX-700P, which has a base list price of $99.95. The notable difference between the FX-700P and the PC-4 is that the FX-700P comes with the maximum amount of memory (1568 steps), while the PC-4 offers the same amount of memory only when you add a $19.95 optional module. In other words, once you add the price of the 1K-byte RAM module to the PC-4, the base list prices of the two computers are about the same. Besides the BASIC commands that the PC-4 has, the Casio computer offers one-key entry of 16 different functions. Casio also markets another version of the computer, the FX-802P ($149.95), which has the same features and functions as the FX-700P, plus a built-in printer.



Casio markets the FX-700P, a pocket computer similar to the PC-4.

A source at Radio Shack says that both the Casio FX-700P and the Radio Shack PC-4 are made by Casio of Japan. However, Ed Judge, director of computer merchandising for Radio Shack, says his company has exclusivity on the PC-4. Thus other differences between the two machines may exist.

Another new pocket computer, the PC-1250 Student Computer Kit ($110), is offered by Sharp Electronics (10 Sharp Plaza, Paramus, NJ 07652, (201) 265-5600). Sharp's computer has a 24-character display, Extended BASIC, and 2.2K bytes of RAM.

Documentation

The PC-4 comes with a 66-page owners manual. The manual includes a few fundamental instructions, such as how to change the batteries and install the RAM pack, and sketchy definitions of the keys and commands, with even sketchier examples of how to use them. If you're familiar with pocket computers or programmable calculators and you have a good understanding of BASIC, you'll find that the owners manual is adequate, but just barely.

On the other hand, if the only programming you understand is what you read in *TV Guide*, you'll agree that the 195-page *PC-4 Programming Guide* included with the PC-4 is a godsend. The guide takes you from the beginning and teaches you how to program the PC-4 in BASIC. It also includes program listings that are ready to type in and use.

Comparisons

The timed tests that I conducted with the PC-4 showed surprising results. For the comparisons, I chose two other pocket computers: the Radio Shack PC-1, a natural choice to compare to its replacement, and the PC-2, for a contrast with a larger, more expensive computer.

I then ran two different programs. The first was a simple, two-line counting loop. The PC-4 completed the loop about twice as fast as the PC-2 and nearly 30 times faster than the PC-1. For the second test, I used a 258-step, prime

Program Commands and Functions

All BASICs are not equal, and different computers have different sets of BASIC statements and program functions. Here's what the PC-4 offers:

- Input statements:
  - INPUT
  - KEY
- Output statements:
  - PRINT
  - CSR
- Branching commands:
  - GOTO
  - IF/THEN
  - GOSUB
  - RETURN
- Looping commands:
  - FOR/NEXT
- Execution interrupts:
  - STOP
  - END
- Variable clearing:
  - VAC
- Program listing:
  - LIST
  - LIST A
- Execution:
  - RUN
- Program erasing:
  - CLEAR
  - CLEAR A
- Mode designation:
  - MODE
- Numeric data formatting:
  - SET
- String handling:
  - LEN
  - MID
  - VAL
- Cassette input/output:
  - SAVE
  - LOAD
  - SAVE A
  - LOAD A
  - PUT
  - GET
  - VER
- Memory allocation:
  - DEFM

Built-In Functions

Here's a list of the PC-4's built-in functions, which are available when you're programming or using the PC-4 as a calculator:

sine
cosine
tangent
arc sine
arc cosine
arc tangent
angular units: degree, radian, gradient
square root
exponential
natural logarithm
common logarithm
conversion to integer
deletion of integer
absolute value
round off
random-number generation
symbolization
pi

factorization program from the *PC-4 Programming Guide* (I made minor changes to accommodate the different models). I chose the prime number 314,957 to use as the test datum. The results were not as dramatic, but the PC-4 did well:

Model	Time
PC-1	11:40
PC-2	1:24
PC-4	1:44

The PC-4 proved its state-of-the-art design against the two-year-old PC-1 and was also the easiest of the three computers to program.

Limitations

The base memory size of the PC-4 may not fill the bill for all applications, and many people will find the RAM module necessary. If your program application is particularly large, like job costing, you may need more than 2K bytes, which would rule out the PC-4 altogether. In such an instance, you should consider a not-so-pocketable computer.

The small LCD with its horizontal scrolling presented no problems during program execution, but viewing only 12 characters at a time while debugging makes a tedious job almost unbearable. I recommend the printer if you plan to debug large programs.

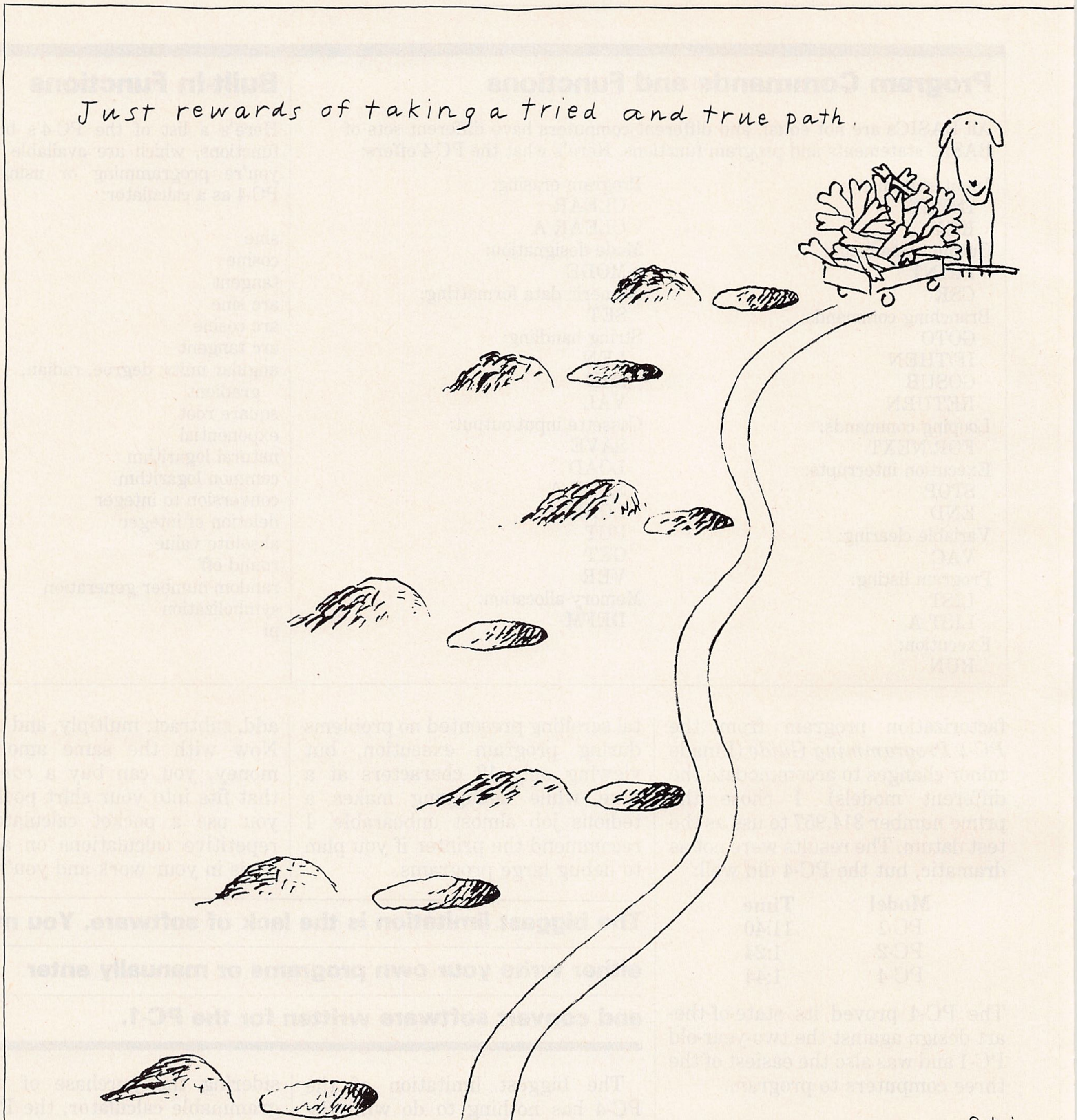
The biggest limitation is the lack of software. You must either write your own programs or manually enter and convert software written for the PC-1.

The biggest limitation of the PC-4 has nothing to do with the hardware but rather with the lack of software. The availability of canned software has been a problem for all pocket computers, and the PC-4 is no exception. You must either write your own programs or manually enter and convert software written for the PC-1.

Who Should Buy the PC-4?

The first calculator I owned cost about $100 ten years ago. I thought it was fantastic, yet it could only add, subtract, multiply, and divide. Now with the same amount of money, you can buy a *computer* that fits into your shirt pocket. If you use a pocket calculator for repetitive calculations on a daily basis in your work and you're considering the purchase of a programmable calculator, the PC-4 is probably right for you. The pocket computer could save you time and offer greater accuracy.

But who *really* needs the PC-4? Students. For the math, business finance, engineering, or chemistry student, the PC-4 is the greatest calculating tool to come along since Amedee Mannheim invented the slide rule. The low price lets the pocket computer and a college student's pocketbook fit together nicely. □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RANDOM ACCESS

A wide-ranging look at ways to get more from your personal computer

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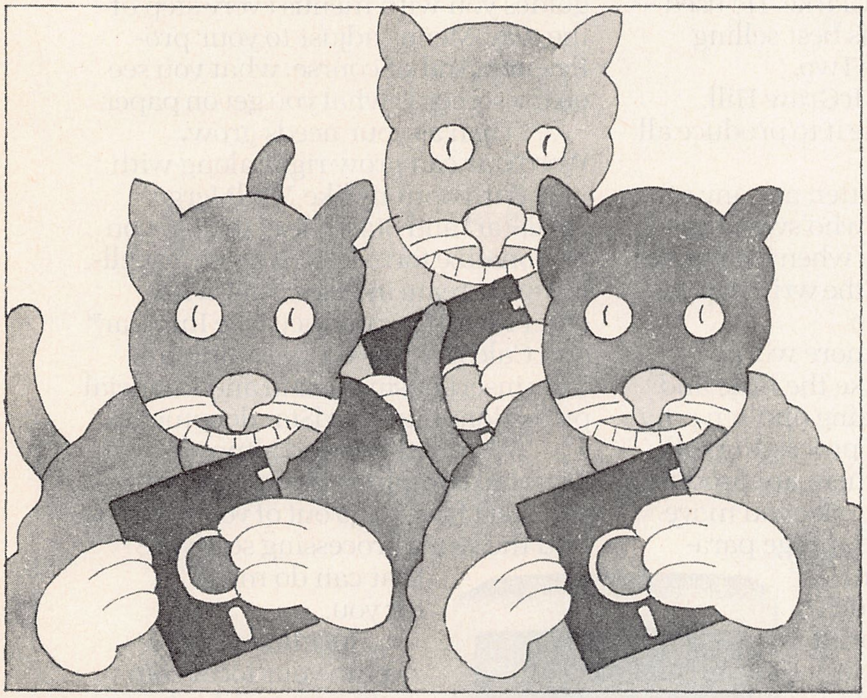
Sending Data by Ham Radio page 170

The $4.04 Printer Stand Page 174

Where to Find User Groups Page 174



"Thou Shalt Make Backup Copies"

If you've ever known that moment of sheer panic when the computer coldly tells you it can't find your accounts receivable, you know firsthand why computer textbooks, data processing instructors, and software manuals all solemnly intone the first commandment of computerdom, "Thou shalt make backup copies."

Backing up your data is a lot like fastening your seat belt. You know it's a good idea, but it's an extra chore, and if it's not part of your regular routine, you may easily forget to do it. While neglect doesn't matter most of the time, if you're unprepared when an emergency does occur, you can't undo the damage that's been done.

Okay, you've resolved to make backup copies. But how do you do it? The techniques differ with different data storage media. Let's look at them one at a time.

Cassette Tapes

Copying an entire cassette tape is a slow and tedious business and one you're likely to put off until tomorrow. It involves repeatedly popping your original and your copy in and out of the cassette recorder as you load each file from one tape and save it on the backup tape.

A better technique is to incorporate your backup routine into your regular work flow. Every time you save a file, save it three times. Save the first two copies back to back on one cassette tape, then pop in a backup tape and save the file a third time. This way, if your original is unreadable for some reason, you can just advance the tape to the next file and try again. If the entire cassette is damaged, you can still retrieve the file from the backup tape.

Floppy Disks

With floppy disks your backup habits should depend on the kind of work you do. If you work intensively with a few files or documents, your main concern should be to keep up-to-date copies of your latest versions. Many word-processing programs give you a hand by automatically storing the previous version of your document with the extension or suffix BAK. If your editing program doesn't do

Illustration by Patrick Blackwell

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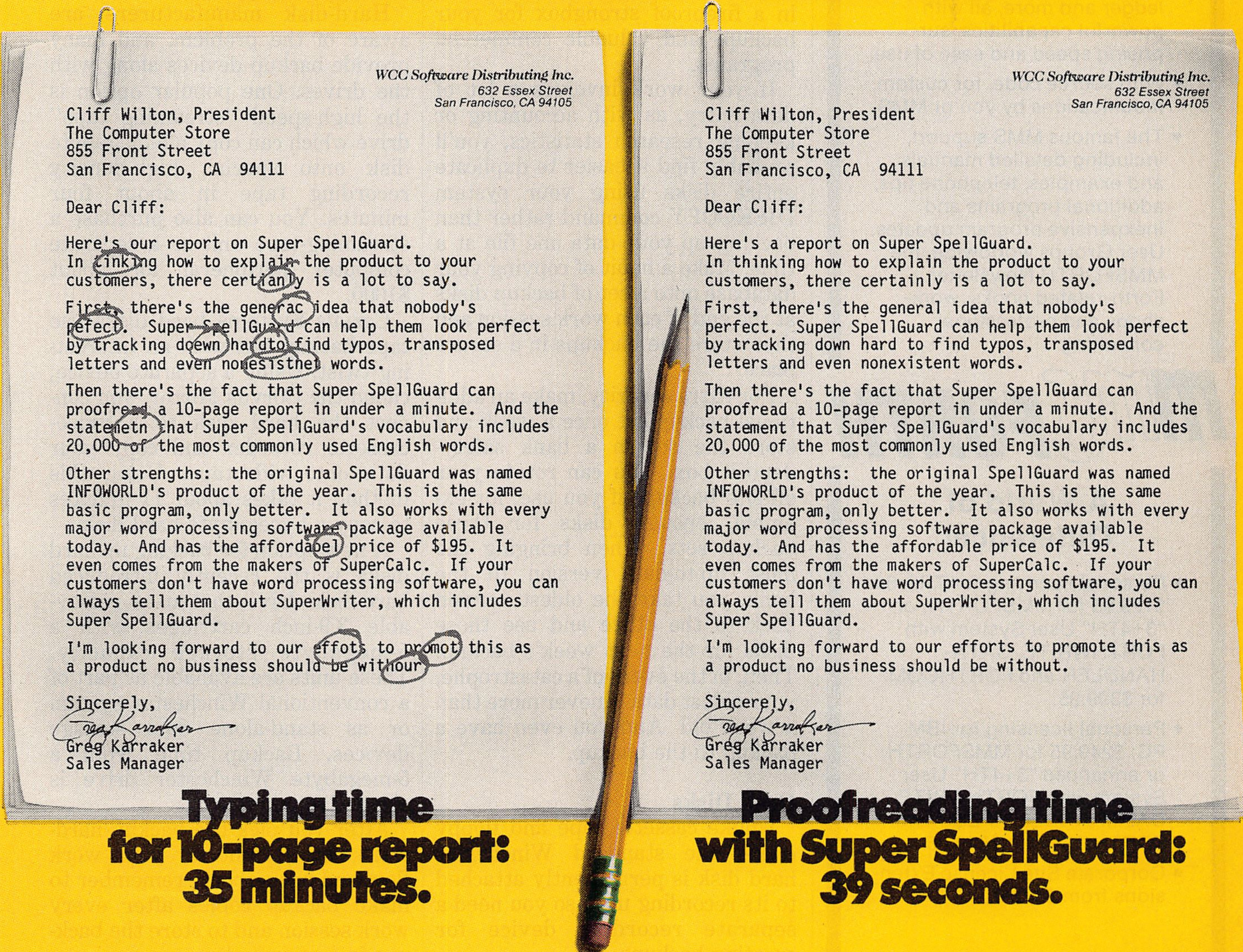

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that, it's a good idea to create such a backup copy yourself every time you save the original document on a disk. Then if you inadvertently clobber your main copy, you have to recreate only your latest additions.

After each work session, before you turn off the computer, copy all your updated documents onto a backup disk. Keep the backup in a secure place, away from the original. You might want to invest in a fireproof strongbox for your backups and valuable commercial programs.

If your work involves a lot of data entry, as with accounting or keeping research statistics, you'll probably find it easier to duplicate entire disks using your system DISKCOPY command rather than backing up your data one file at a time. Make a habit of copying your database onto a set of backup disks at the end of each work session and then store the backups in a secure place.

For extra security, make an additional backup set once a week and store the set in a bank safety-deposit box. You can rotate your off-site backups if you use, for example, enough disks for three backup sets. When bringing the most up-to-date version to the bank, you take the oldest version back to the office and use those disks for the next week's backup. Then, in the event of a catastrophe, your oldest data is never more than a week old. And you even have a backup to the backup.

Hard Disks

Unlike cassette tape and floppy disks, the standard Winchester hard disk is permanently attached to its recording unit, so you need a separate recording device for creating backups.

Perhaps the least expensive solution is to copy the hard-disk data onto floppy disks, especially if you already have a floppy-disk drive for reading in purchased software. This method makes sense if you change only a few files or documents at each work session. Then you can copy your latest versions onto one or two disks.

However, if you typically work with many large files or with a large, integrated database, backing up the data on floppy disks begins to be impractical. To make a backup copy of a 5-megabyte hard disk you would need 32 floppy disks with a 160-kilobyte capacity or 14 floppy disks with a 360-kilobyte capacity.

Hard-disk manufacturers are aware of the problem, and many provide backup devices along with the drives. One popular option is the high-speed "streaming tape" drive which can copy a 5-megabyte disk onto special, high-density recording tape in about four minutes. You can also purchase a streaming-tape unit as a separate computer peripheral for about $1000.

Corvus Systems hard disks use tape backup but with an interesting twist. Using a separate device, called the Corvus Mirror, you connect the hard disk to a videocassette recorder and copy your data onto videotape. Using this method it takes about 11 minutes to copy a 5-megabyte hard disk.

A new option for backing up hard disks is the recently introduced hard-disk drive that uses removable 3.9-inch cartridges with a 5-megabyte storage capacity. These units are available as part of a conventional Winchester system or as stand-alone data storage devices. Backup time from a 5-megabyte Winchester drive is about five minutes.

After you pick the backup hardware that's right for your work flow and pocketbook, remember to make backup copies after every work session and to store the backups in a secure place.

Making backups requires self-discipline, and you may be tempted to forgo the routine when you're tired or running late. Don't give in, lest the computer cease to be your trusty helper and turn into an unreliable bungler. —Dara Pearlman

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Sending Data by Ham Radio

When you think of computer data communications, you probably also think of Ma Bell, modems, and mammoth phone bills. But a group of amateur radio operators thinks there's a better way. It's called "packet radio."

Although still in its infancy, packet radio technology can already offer considerable cost savings to bulletin-board devotees who run up high phone bills in their search for public-domain software or CB-style computer chat. That's because once you buy the equipment, you pay no ongoing phone charges; the radio waves are free.

However, if you have visions of bypassing the phone system for your business electronic mail, be warned: today's packet radio networks use amateur (ham) radio frequencies that by law cannot handle commercial transmissions. That doesn't rule out future commercial use on other radio bands, but today's packet radio is strictly for nonprofit use.

The Basics

What is packet radio? It's a way of sending the electronic information in your computer's memory to another computer in small bursts or "packets" via the radio waves. A packet can be up to 256 characters long and, like a mail parcel, has address information and a verification technique—the electronic equivalent of insurance—to make sure that the packet received is identical to the packet sent.

Here's an example of how packet radio works. Suppose you've just worked out a way to make your IBM Personal Computer play Tchaikovsky's "1812 Overture" with your printer standing in for the cannon, and you want to share the discovery with your friend on the other side of town. You turn on your radio transmitter, a second-hand marvel that you picked up for $50 at a flea market. Then you type in a few commands to your "terminal node controller," a special circuit board that encodes and decodes the packets, and soon you hear the electronic singsong that means your program is on its way. Each tone indicates another transmitted packet.

If your friend doesn't have his receiver turned on, you can route your message to his "mailbox" at

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the local packet radio club's repeater station. The receiver there is hooked up to another terminal node controller that decodes each packet as it arrives and recomputes the "insurance" values to insure accuracy. If the insurance values don't match, the controller tells the transmitter to send the packet again. That way you can be sure the program won't be garbled in transit.

Thus, you can see that to join the packet radio ranks, you need a transmitter/receiver, a terminal-node-controller board, and another packet radio operator to talk to. You also need an amateur radio license. Let's tackle these one at a time.

Because packet radio uses relatively high frequencies, usually near the commercial FM band, you don't need very expensive radio equipment. A new set sells for about $300, and a used set costs much less. Terminal node controllers are a new item for home computers, and as of this writing, they were not available ready-made from commercial suppliers. An enthusiastic group of ham operators in Tucson, Arizona, who formed the nonprofit Tucson Amateur Packet Radio Corporation (TAPR) in late 1981, designed a terminal node controller that was undergoing final testing in April. The group was planning to sell the controller in kit form, together with software, for between $200 and $300.

Expanding Networks

Since late 1982, when the Federal Communications Commission (FCC) agreed to allow packet radio transmission on the amateur radio frequencies, TAPR has grown to 300 members nationwide and has set up 19 beta-test networks across the country to test the terminal node controllers and related software. Each network or "metro-net" covers a single metropolitan area, often with repeater stations on mountaintops to enable members to communicate with each other over longer distances.

Repeater stations are necessary because packet radio communications rely on line-of-sight contact. Packet radio enthusiasts are working on ways to overcome this limitation and establish links between metro-nets. One of the most exciting experiments involves the use of a communications satellite built by volunteers associated with the nonprofit Radio Amateur Satellite Corporation (AMSAT) based in the Washington, D.C., area.

Leading the Way

Phillip Karn, assistant vice-president for engineering with AMSAT, explains that his group has built four of the nine ham radio satellites currently orbiting the earth. Usually these OSCARs (Orbiting Satellite Carrying Amateur Radio) hitch a ride on commercial launches and settle into low earth orbits, where they are visible to earthbound hams for 15 minutes at a time, several times a day. The newest satellite, which was scheduled for a June 1983 launch date, was destined for a high earth orbit, where it will be visible throughout most of North America for as long as 9 to 10 hours at a time. From its orbit the satellite will act as an ultrahigh repeater station, boosting radio signals from all over the country. The plan is to reserve one channel on the satellite for packet radio experiments, and if the launch was successful, experiments may already be going on as you read this.

AMSAT has another packet radio project still in the planning stages called PACSAT, for "packet radio satellite." Slated for launch in 1985 or 1986, PACSAT will be an orbiting digital "mailbox." Like the earlier OSCARs, it will travel in low earth orbit, allowing ground stations a 15-minute communications window. But instead of boosting real-time transmissions, PACSAT will store the transmission in some kind of solid-state memory device such as random-access mem-

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ory or bubble memory and then send the transmission back to earth when the addressee is in sight.

Part of the funding for PACSAT comes from another nonprofit group, Volunteers in Technical Assistance (VITA), which answers queries on technical topics from developing countries. Gary Garriott, senior technical advisor with VITA, explains that international mail can be excruciatingly slow, forcing people to wait three to four months for an answer to a technical question. And with a volume of 300 to 400 queries a month, international Telex is beyond VITA's budget. But once PACSAT is launched, VITA will be able to use AMSAT's worldwide network of licensed ham radio operators to get answers back as soon as they are prepared.

Like the home computer hobbyist, VITA will use packet radio to bypass Ma Bell and the high price of telephone links. And that brings us back to the last requirement for communicating via packet radio, an amateur radio license.

To get an amateur radio license, you need to pass a test demonstrating your mastery of technical theory and your ability to send and receive Morse code. The Morse code requirement is probably the major barrier to computer hobbyists who might want to try packet radio and is currently a matter of intense debate among radio hams. When this article went to press, the FCC was considering a class of license without the Morse code requirement, and by the time you read this, the new license may already be available.

If you want more information on packet radio, write to the Tucson Amateur Packet Radio Corp., POB 22888, Tucson, AR 85734. Membership is $12, and in return you get (excuse the expression) a "packet" of information, a bimonthly newsletter, the *Packet Status Register*, and the opportunity to participate in the testing of new hardware and software. —Dara Pearlman

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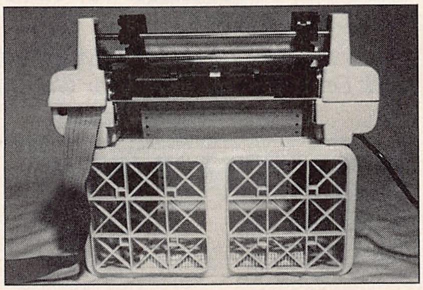
Do you need a printer stand but dislike the high prices being charged? That was my problem too. It always seemed better to buy another program or more disks rather than succumb to the temptation to buy another piece of furniture for the system.

Then one day while browsing in K-mart, I literally stumbled over my $4.04 printer stand as I turned down a narrow aisle. There at my feet was a plastic Storage Mate module measuring 14 inches wide by 7 inches high by 13½ inches deep. It was one of a collection of pieces made to assemble into a section of wall storage. Realizing that it was strong enough to support my printer and looked large enough, I took a chance and bought a module. Once home I slid it under the printer—it was almost as if they were made for each other.

With a stiff-bladed sharp knife, I carefully cut out a section in the top of the module so the paper could come into the bottom feed slot of the printer. The stand is sturdy, lightweight, colorful, and because of its open design, well ventilated. I have since seen other modules made of various materials and with different designs that would work just as well, so look around. With a good ruler, ingenuity, and a minimal amount of work, you too can have a low-cost printer stand.



—Ronald J. Neldner

Where to Find User Groups

Put two or more owners of a particular computer in the same room, and the first thing they'll probably do is form a user group. User groups (also known as special-interest groups) are high-tech's answer to fan clubs. Besides providing system owners with a chance to meet and enjoy the company of fellow enthusiasts, user groups are also a great way for beginners and experts to acquire news and information on the entire world of computing. Depending on the group, activities can range from informal discussions on the latest programming techniques to testing a member's new program creation to soldering together some circuits on the group's prototype computer.

Unless you live in a major city, finding a local user group can be tricky—especially if your interest lies in a system that lacks a wide following. The best way to obtain information about hometown groups is to visit a computer store. Most dealers either keep records of area groups or maintain a showroom bulletin board where organizations can post announcements of upcoming events. Your computer can also help you find area users. If your system includes a modem and communications program, check

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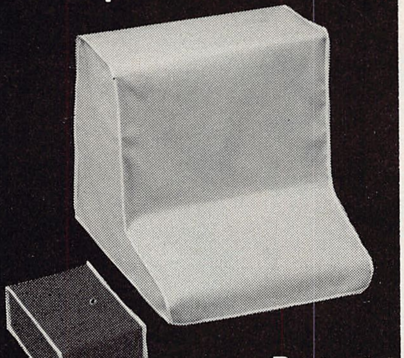

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nearby electronic bulletin boards for details on active groups. Finally, if all else fails, try going to a meeting of a group that concentrates on another manufacturer's equipment. Chances are you'll find someone there who can point you in the right direction.

The level of support for user groups varies widely among manufacturers. For instance, while Atari and Heath/Zenith support and nurture user groups, most other companies follow a policy of laissez-faire. Few manufacturers actually help budding groups get off the ground. The following summary provides addresses for a few of the user groups for the most popular home computers.

Apple

Many industry observers have attributed much of Apple's incredible success to its user groups. Back in the early days, when Apple could offer prospective customers only a machine and a handful of applications programs, user groups developed many of the software and hardware additions that current Apple owners take for granted. But while Apple owes much of its early success to its user groups, the company does not have much contact with them.

Interested system users should have little difficulty finding an active group in their area. Some of the larger Apple groups are the International Apple Core, 908 George St., Santa Clara, CA 95050; The Big Apple Users Group, POB 490, Bowling Green Station, New York, NY 10274; Northern Illinois Apple Users Group, 1271 West Dundee Rd., Buffalo Grove, IL 60090; and Boston Apple Users Group, 3 Center Plaza, Boston, MA 02108.

Atari

Atari's support of user groups is one of the most extensive in the industry. In addition to providing groups with stickers, newsletters, posters, and videotaped factory tours, the company also offers a free start-up kit. For details on beginning or joining an Atari user group, write Atari Computer Users Group Support Program, POB 50047, San Jose, CA 95150.

Commodore

Many Commodore user groups have been around for six or more years (veritable dinosaurs in the hyperaccelerated world of microcomputers). While most groups started operation to meet the needs of PET owners, the emphasis today is on the VIC-20 and Commodore 64 computers.

Support from Commodore includes a magazine and a Compuserve user network. For additional information, write Commodore, Computer Systems Group, 487 Devon Park Dr., Wayne, PA 19087.

Heath/Zenith

Heath/Zenith believes in its user groups. One of the pioneers in local user organization, HUG (Heath Users Group) offers its members a monthly magazine, a personal identification card, and access to a software library (tape and disk copies of programs are available for a nominal reproduction charge). HUG's first-year membership fee is $18 (renewals cost $15). Individual chapters may also request an additional payment to support local activities. For a list of local groups, write HUG, Hilltop Rd., St. Joseph, MI 49085.

IBM

According to an IBM spokesperson, user-group support is the responsibility solely of the company's local dealers. If a dealer cares only about meeting his monthly sales quota, then the success or failure of the local user group will depend upon the skill and initiative of the group members alone.

Incidentally, IBM does not keep a list of user groups. Try to get information from a local Computerland, Sears, or IBM Business Products Center. You might also try writing to IBM PC Club and News,

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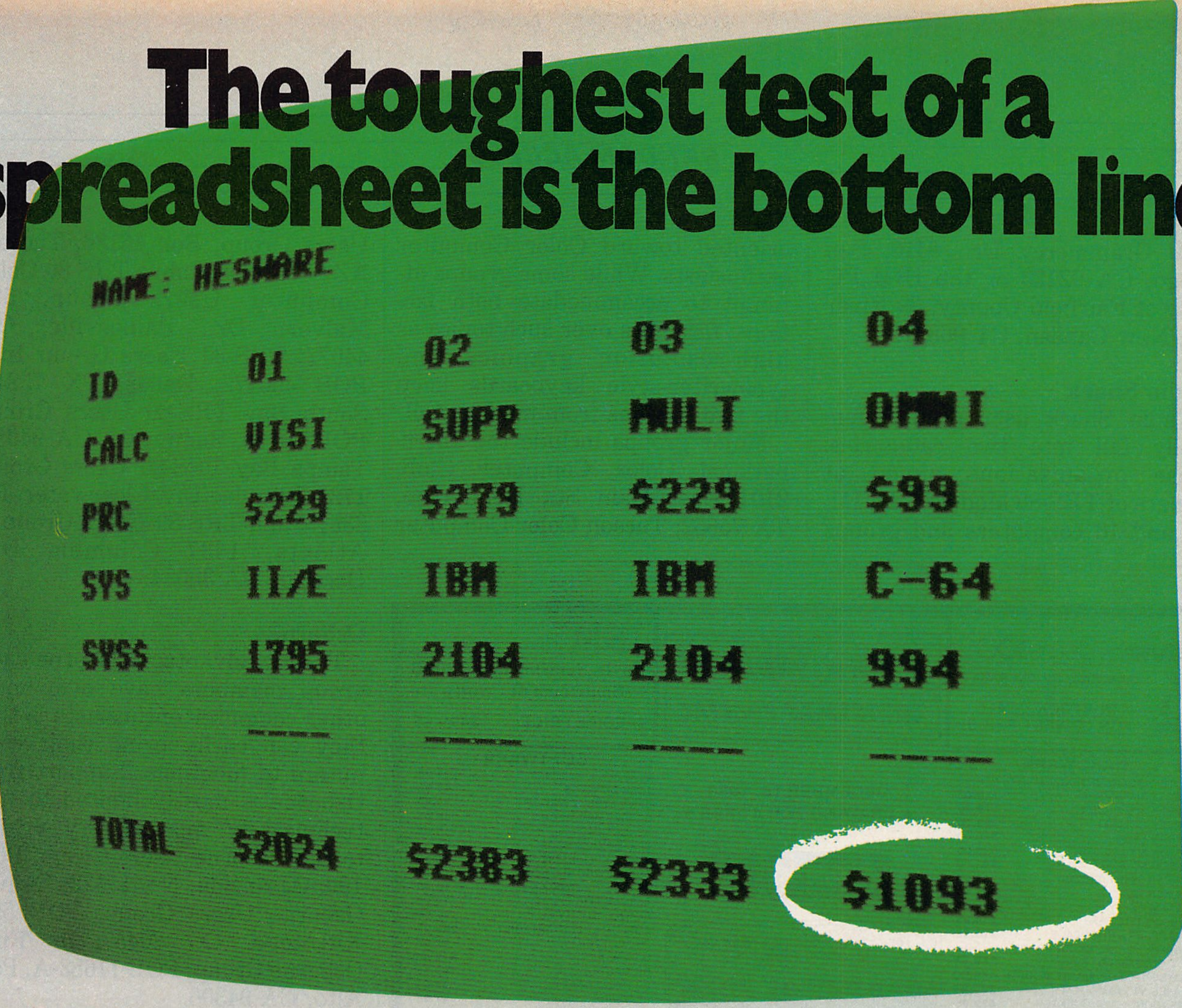

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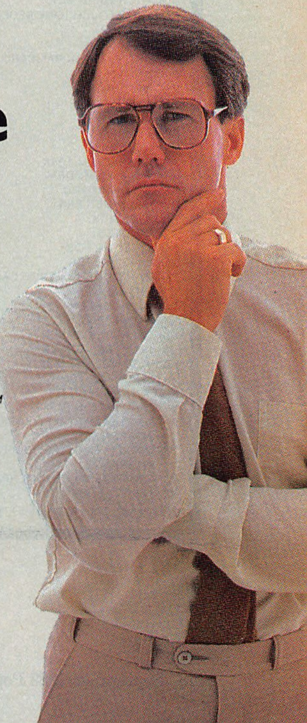

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9120 Grammercy Dr., #416, San Diego, CA 92123 or the IBM PC Club of Fairfield County, 69 River St., New Canaan, CT 06897.

Radio Shack

Radio Shack user groups generally fall into two categories: those organizations aimed at owners of TRS-80 Models I, II, III, 12, and 16 computers and groups oriented toward Color Computer enthusiasts. While some groups attempt to accommodate both factions, fistfights over such topics as high-resolution graphics and typewriter-style keyboards keep the two factions from mixing well.

Major groups include the International Color Computer Club, 2101 East Main St., Henderson, TX 75652; Tucson Color Computer Users Group, Box 15186, Tucson, AZ 85708; Columbus TRS-80 Color Computer Users Group, 527 Malvern Dr., Painesville, OH 44077; TRS-80 Users Group Inc., POB 400472, Dallas, TX 75240; South Bay TRS-80 Users Group, POB 60116, Sunnyvale, CA 94088; Tampa Bay TRS-80 Users Group, 1721 Greenlee Dr., Clearwater, FL 33515; and TRS-80 Users Group of Atlanta, 1637 Columbia Dr., Decatur, GA 30034.

Osborne

The big advantage Osborne user-group members have over most other computer enthusiasts is that they can easily bring their computers to meetings. Support from Osborne is mostly limited to free technical information. Try writing to the Osborne Users Group, POB 190, Oceanside, NY 11572; Denver Osborne Users Group, POB 521, Kittredge, CO 80457; or First Osborne Group, POB 11683-A, Palo Alto, CA 94306.

Texas Instruments

TI user groups are a healthy and expanding breed. TI itself offers little in the way of direct support, but according to a spokesperson, the company "will consider reasonable requests for assistance." Try writing to the TI 99/4 Users Group, Box 267, Leesburg, VA 22075; MSP 99 User Group, POB 12351, St. Paul, MN 55112; or St. Louis 99ers, 3429 Pesta Lozzi, St. Louis, MO 63118.

Timex/Sinclair

The company that makes those little computers has lots of users but not many user groups. In fact, we couldn't find a single Timex employee who had even heard of a user group. For information, you'll have to go outside the company. Try contacting the ZX Timex Users Group, Box 2443, Titusville, FL 33742; Sinclair Users Network, 2170 Oak Brook Circle, Palatine, IL 60074; or ZX81/TS1000 Users, POB 2411, Vista, CA 92803.

—John Edwards

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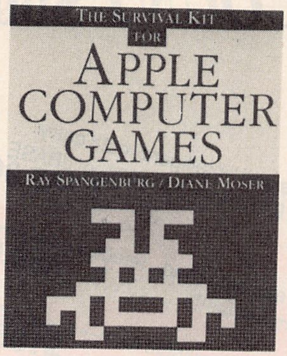
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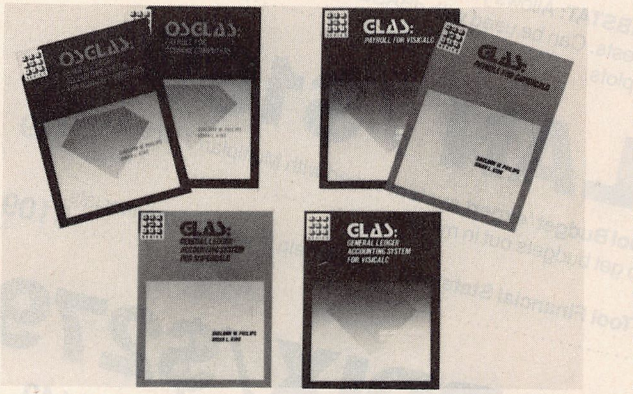
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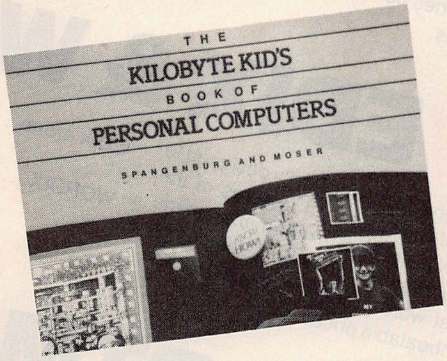
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Monty Plays Scrabble

High tech's answer to the Scrabble addict's dreams

by John Edwards

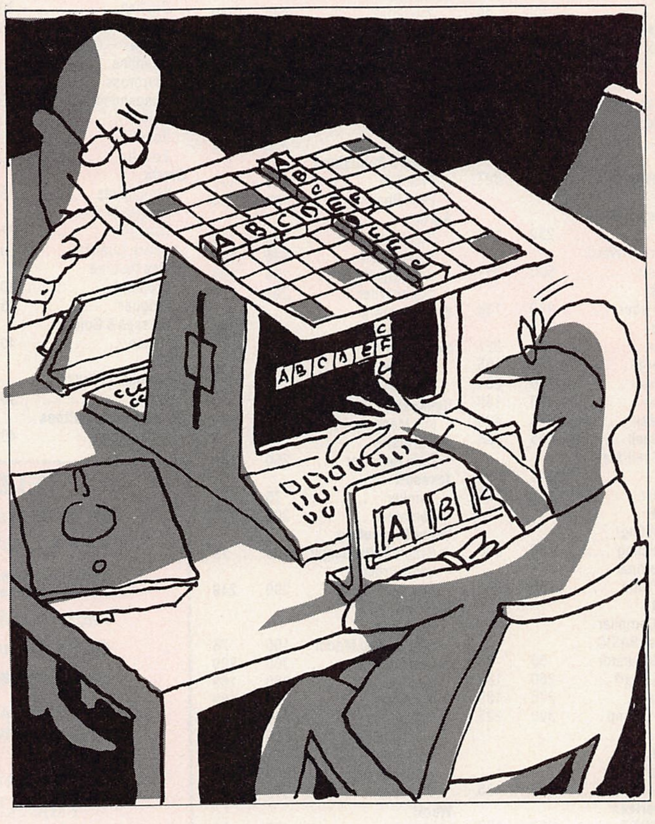
When I was a boy, Saturday night was company night in the Edwards household. It was the evening when relatives, neighbors, former neighbors, and sweethearts would drop in to spend the evening. Back in those innocent 1950s, Saturday night's main pleasures came at the dining room table—first dinner, then board games. My family owned an extensive library of these amusements, including such titles as Parcheesi, Monopoly, Life (promoted on TV by Art Linkletter), Sorry, and a German import with the curious name of Mensch Argere Dich Nicht! (loosely translated: Don't Get Angry, Man!).

Despite the Edwards' intense love of board games, I must confess that my particular favorite was one not often played by my family—Scrabble. Among my parents' predominantly blue-collar friends, Scrabble was regarded as a somewhat elitist game. I enjoyed Scrabble, but it took a supreme amount of cajoling to get anyone in my family to play the game with me.

Had I been born two decades later (and equipped with either an Apple II or TRS-80 Model I or III microcomputer), my search for a willing Scrabble opponent would have ended at the computer keyboard. Monty Plays Scrabble, a computerized version of the classic board game, is high technology's answer to the lonely Scrabble addict's dreams. With a vocabulary of more than 54,000 words, Monty is the perfect opponent—willing to play at any time and never a sore loser.

For those not familiar with its rules, Scrabble is a crossword-puzzle game that can be played by two to four persons (one to three people in the Monty version). The players must form interlocking words on the Scrabble playing board using letter tiles with various score values. Each player competes for high score by using his letters in combinations and locations that take best advantage of letter values and premium squares on the board. The combined total score for a game ranges from about 500 to 700 or more points depending on the skill of the players.

Many readers may already be familiar with the computerized version of another popular board game—Monty Plays Monopoly. In a switch from the Monopoly venture, Monty's manufacturer, Ritam Corporation, has managed to secure the approval of Scrabble's maker—Selchow and Righter—for the computerized version. This move carries with it more than mere legal significance because Selchow and Righter's blessings mean that the computerized version can feature a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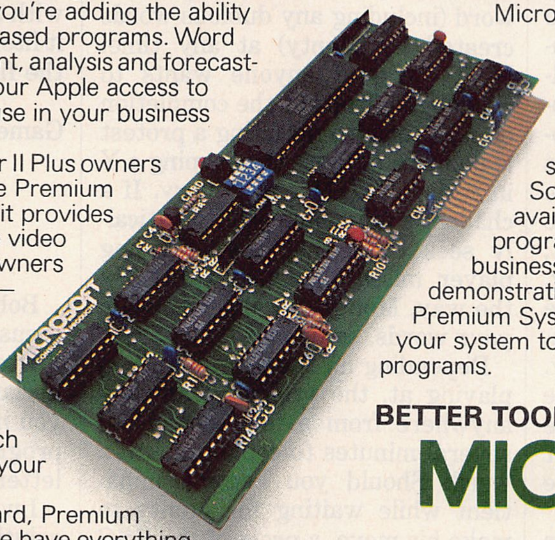

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representation of the actual Scrabble board on the computer's display (Monty Plays Monopoly and an earlier version of the Scrabble program required users to play along on a conventional game set).

The Amazing Monty

Bringing Monty to life requires inserting the program disk into your drive and pressing the appropriate keys to boot your system. After the customary whirs and clunks, a title screen unfolds on your display to the tune of Richard Strauss's "Thus Spake Zarathustra" (a melody that was the main theme in the movie *2001*). As the title screen fades away, Monty marches into view from the left (to the accompaniment of Elgar's "Pomp and Circumstance"), makes a brisk right turn, and tells you what a "great joy" it is to play with you. (Polite little chap.)

Once Monty has finished introducing himself, he asks you to select a level of play. Ever-thoughtful fellow that he is, Monty is willing to alter his intellect to four different levels—Novice, Intermediate, Advanced, and Scholar—to meet the skills of his opponents. At each level Monty appears on the screen in different garb. For example, as a Scholar he wears cap and gown; as a Novice he's dressed in shirtsleeves. Next, Monty asks who he will be playing. The names are entered into the computer in a clockwise rotation, beginning and ending with Monty. Following this procedure, the users choose the method of tile selection (tiles can be dealt either automatically by Monty or by the players).

After all the formalities have been completed, it's time for the actual game to get under way. Playing Scrabble with Monty is very much like playing with any other partner (although Monty, unlike some opponents I've faced, is much too honorable to cheat). Players enter words into the keyboard from the row of seven electronic tiles presented on the screen. To position the tiles in the proper locations, players tell Monty whether the word is to run vertically or horizontally and then use a diamond grid of keys that rapidly move the word to any section of the board. Monty keeps track of each player's score, including bonus points.

To meet the skill of his opponents, Monty can alter his intellect to four different levels—Novice, Intermediate, Advanced, and Scholar.

Because Monty observes all standard Scrabble rules, users can expect to encounter the usual array of traditional game features. Included on Monty's electronic board are spaces for double and triple words and letters. Blank tiles are available (indicated by an asterisk), along with a bonus for emptying your rack at the conclusion of a game. As in the regular board game, a player may challenge the authenticity of another player's word (including any dubious words created by Monty) at any time. Monty asks if anyone wants to challenge a word at the completion of each turn, so initiating a protest is no more difficult than typing a Y in response to Monty's query. If a challenge fails, Monty automatically sees to it that the offending player misses his next turn. (By the way, Monty can also challenge *your* words, so be careful.)

Depending on the level Monty is playing at, the program can take anywhere from a few seconds to several minutes to come up with a word. Should you become impatient while waiting for Monty to make his move, a press of the ESC key tells him to play the best word he's thought of so far. It's also possible to change Monty's skill level during the course of a game (from a menu-options board that also enables players to exchange tiles, check scores, save games on a disk, and perform other special chores). As in regular Scrabble, a game ends as soon as one of the players has emptied his rack or when it's impossible for another word to be played. By choosing the end-the-game option from the menu, a player may terminate a game at any time.

Monty's First Party

To give Monty a proper run-through, I decided to revive my parents' tradition of inviting company over on a Saturday evening. For this special event, I assembled a group consisting of Robert Swirsky (a frequent contributor to this magazine), James Edwards (a computer science student and my younger brother), and myself (a world-renowned writer). After a few cocktails to get into the mood and a sumptuous buffet, it was time for my pals to meet Monty.

Because a gracious host wouldn't allow his guests to be clobbered on the very first game of the evening, I set the program to the Novice level. I shouldn't have bothered. Not only did Monty conquer my friends (I managed to squeak by with a score of 142 to Monty's 122), it literally trounced them. Here are the final results:

Game Time: 58 minutes
John—142
Monty—122
Bob—99
Jim—87

Bob and my brother immediately accused me of rigging the game. "After all, it's your computer," declared Bob. "How do we know you haven't done something to the program to make it give you good letters?"

I was in a fix. The only diplomatic solution was to bow out of the next

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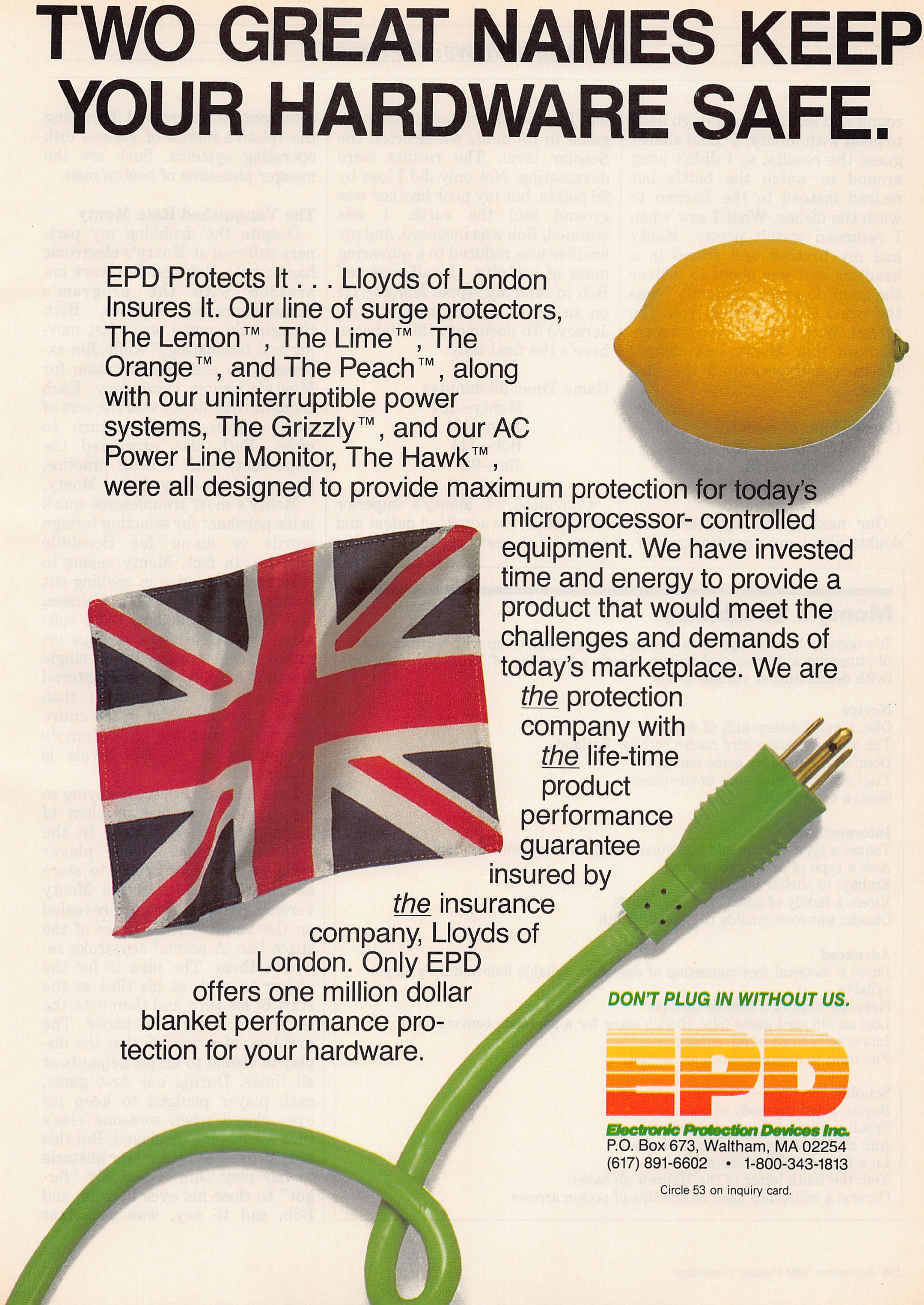
John Edwards is a *Popular Computing* contributing editor based in Queens, New York.



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round and let Bob and Jim go head to head with Monty. I could almost guess the results, so I didn't hang around to watch the battle but retired instead to the kitchen to wash the dishes. What I saw when I returned wasn't pretty. Monty had my brother and friend in a headlock and was about to deliver the coup de grace. "Silently" was the word Monty flashed onto the screen. With that, the program announced that Monty had cleared his rack and presented the final score:

Game Time: 47 minutes
Monty—231
Jim—175
Bob—142

Our next game squelched any doubts about my program-tampering. In a foolish attempt to take the game to its limit, we selected the Scholar level. The results were devastating. Not only did I lose by 26 points, but my poor brother was ground into the earth. I was stunned, Bob was incensed, and my brother was reduced to a quivering mass of self-pity. (I half-expected Bob to send my Apple Monitor III on an aerial journey toward New Jersey.) To document this debacle, here's the final tally:

Game Time: 93 minutes
Monty—187
John—161
Bob—114
Jim—98

Convinced of Monty's superior word skills, we admitted defeat and spent the rest of the evening cataloging programs and discussing the relative merits of various disk operating systems. Such are the meager pleasures of beaten men.

Monty's Vocabulary

It's terribly humiliating when a computer game comes up with words capable of stumping a professional writer. Here's a sampling of Monty's vocabulary (with definitions) at various levels:

Novice
Oke: a mid-Eastern unit of weight
Tui: a honey-eating bird native to New Zealand
Dom: a title used by some monks
Fug: a stuffy or odorous environment
Suet: a type of fat

Intermediate
Toque: a type of women's hat worn during the sixteenth century
Azo: a type of carbon compound
Embay: to shelter something
Vireo: a family of small American birds
Giaour: someone outside the Muslim faith

Advanced
Iamb: a metrical foot consisting of one short syllable followed by a longer syllable
Neb: the beak of a bird or tortoise
Loo: an old card game (also British slang for a porcelain convenience)
Inure: to become of advantage
Fie: used to express shock or disgust

Scholar
Bayou: a marshy body of water
Triad: a musical chord of three notes
Ani: a type of American black cuckoo
Li: a Chinese unit of distance
Yod: the tenth letter of the Hebrew alphabet
Curare: a substance used on the tips of poison arrows

The Vanquished Rate Monty

Despite the drubbing my partners suffered at Monty's electronic hands, both Bob and Jim were impressed with the program's Scrabble-playing abilities. Both thought the game was "fast moving and fascinating," while Jim expressed no end of admiration for Monty's sizable vocabulary. Each thought that Monty was the sort of game players would return to often. Both also expressed the hope that, with a little practice, they could return to defeat Monty.

Monty's most troublesome quirk is his penchant for selecting foreign words (a no-no for Scrabble purists). In fact, Monty seems to take particular glee in spelling out letters from the Greek, Chinese, and Hebrew alphabets. The software also possesses a strange ornithological streak. In a single evening of play, we encountered more obscure bird species than John J. Audubon did in his entire life. (A sampling of Monty's vocabulary at various levels is shown at left.)

Less critical yet still annoying to my friends was the problem of keeping the tiles hidden. In the traditional game, each player receives a rack on which to store and hide his tiles. In the Monty version, players' tiles are revealed on the screen with a press of the space bar. A second keystroke removes them. The idea is for the player to peek at his tiles at the start of his turn and then note the letters on a scrap of paper. The problem, of course, is that the display is visible to all participants at all times. During our first game, each player pledged to keep his eyes closed when someone else's tiles were being displayed. But this soon proved to be a major obstacle to fair play. Jim repeatedly "forgot" to close his eyes in time, and Bob, sad to say, was a blatant

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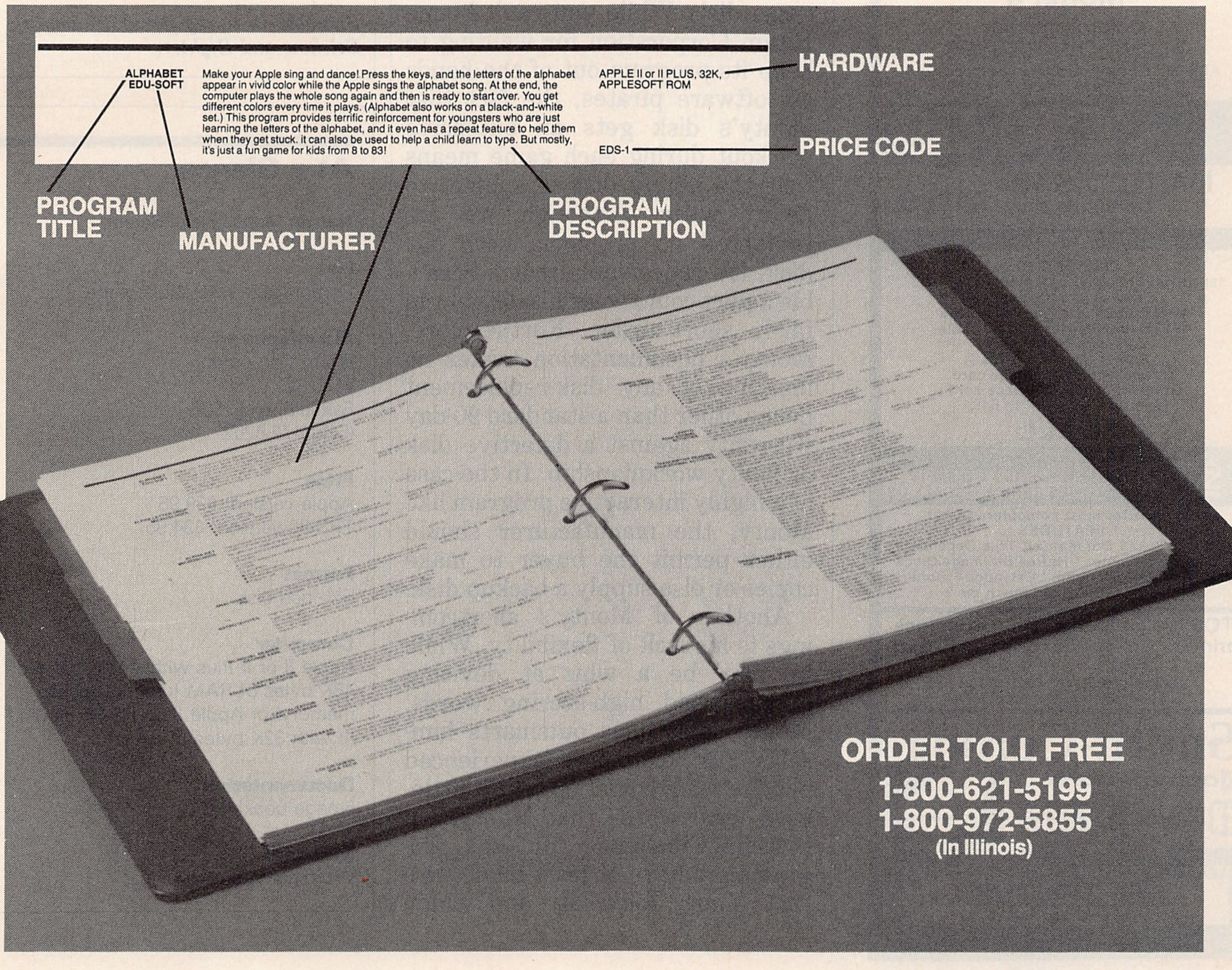

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cheater. By the start of the third game, we unanimously resolved to skip the entire farce and just view each other's tiles. Albeit a less cumbersome procedure, tile-glimpsing did remove an important element of strategy from the game. At any rate, Monty would have no part of our little agreement and elected to keep his tiles invisible.

Like most games in its price class, Monty comes packaged in a small plastic envelope with a single disk and a short documentation booklet. While the documentation was thorough and generally told us everything necessary to operate the software, it was woefully short on Scrabble theory and rules. I would have liked to have seen at least a small section devoted to Scrabble strategies—much as the instructions accompanying the board game include.

Most disturbing is the matter of Monty's single copy-protected game disk. While you can't blame Ritam Corporation for wanting to keep its program out of the hands of software pirates, the fact that Monty's disk gets an extensive workout during each game means that the floppy disk is subject to heavy wear. Although we experienced no problems with our disk, it's conceivable that a Scrabble addict could wear his disk out in fairly short order. Furthermore, Monty's documentation makes no mention of any disk-replacement policy other than a standard 90-day warranty against a defective disk or faulty workmanship. In the case of a highly interactive program like Monty, the manufacturer should either permit the buyer to make copies or else supply a backup disk.

Another of Monty's shortcomings is his lack of flexibility. While he may be a whiz at devising obscure and high-scoring words, Monty sometimes outsmarts himself. For example, experienced players can come up with little-used legal words that Monty will certainly challenge. But the programmers have at least made sure that Monty *looks* sly and whimsical. When Monty plays a word, a light bulb flashes over his head. If the word happens to be particularly good, smoke rises from his skull. I've never been intimidated in quite that fashion by a human player.

For a relatively modest price, Monty Plays Scrabble is a fascinating exercise in programming that should give its owners more than their money's worth of fun. Nevertheless, I'd still take on an interesting flesh-and-blood opponent over Monty any day. After all, those Saturday nights in the '50s would have been dull as dishwater if all my parents' friends were huddled around a computer screen.

Meanwhile, I'm keeping my eyes on Ritam to see if the company is planning a game called Monty Plays Vegas. It'd be a lot cheaper than flying to Nevada to see Wayne Newton, that's for sure! □

Scrabble is a registered trademark of Selchow and Righter.

At a Glance

Name: Monty Plays Scrabble

Use
Computerized Scrabble game

Manufacturer
Ritam Corporation
POB 921
Fairfield, IA 52556
(515) 472-8262

Price
Apple version: $39.95
TRS-80 version: $34.95

Format
5¼-inch disk

Computer
Apple II or II Plus with Applesoft and 48K bytes of RAM (random-access memory) or Apple IIe; TRS-80 Model I or III with 32K bytes of RAM

Documentation
5-page booklet

Audience
Word-game enthusiasts

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HOME/BUSINESS

Timberline Spreadsheet

From Oregon's timberland comes a package you'll want to "log" on to

by Robert Moskowitz

Although the Timberline Spreadsheet Calculator isn't the best spreadsheet on the market, several things do make it unique. Timberline runs on the UCSD p-System and can support as many users as your hardware can handle. (The version of Timberline for the IBM Personal Computer—the one reviewed here—supports only a single user.) Also, you can tell right away which of Timberline's features are ho-hum and which are truly noteworthy simply by flipping through the well-organized documentation binder. The manual even has a few "Zen Digital" passages, such as this quote from *Kon-Tiki* author Thor Heyerdahl that heralds the index:

> *If, for example, you put out to sea on a wooden raft with a parrot and five companions, it is inevitable that sooner or later you will wake up one morning and begin to reflect on it.*

Aw, heck—one non sequitur does not a bad documentation manual make. The other 262 pages did exactly what they were supposed to do: teach me how to use the program's niftier features. Without delving further into the wit and wisdom of a sun-crazed Norwegian sailor, let's take a look at some of those outstanding features.

Function Keys

Timberline Spreadsheet makes good use of the IBM Personal Computer's eight special-function keys. One key initiates the cursor-move function so you can either type in the destination coordinates or jump to a second display window. Function key F5 lets you determine the number of digits (0 to 9) you want displayed to the right of the decimal point. The same function key also sets column widths (2 to 76 characters).

Timberline's Edit line becomes a stand-alone calculator when you press the F3 function key. You could, for instance, calculate what a freelance writer nets per hour on a $2000 *New Yorker* article by entering .70 (the estimated percentage the writer keeps after taxes) times 2000 divided by 60 (the number of hours it took to write the feature). Without leaving the Edit line, the Timberline program calculates your answer ($23.33 per hour), which you could then enter into any of the spreadsheet cells.

Coordinates

As with most other spreadsheets, Timberline lets you enter absolute coordinates, for example, R5C2 to reach row 5, column 2. But the program also offers *relative* coordinates. R-2, for example, moves you to the cell that's two rows directly above the one you're currently working in. You can also locate a value by its label rather than its grid location. In other words, if the unwieldy dollar amount $6,323,298 found in column 2, row 2 is labeled Gross Sales, all further calculations in that column can be performed by typing, say, .20*'GROSS SALES'—obviously a real time-saver.

Collecting Data from Other Files

Another useful Timberline feature enables you to retrieve data from previously created files for use in the current spreadsheet. For example, you can have your spreadsheet read a bottom-line value derived from complex calculations in another model. This feature also lets you consolidate profit/loss figures from other spreadsheet files spanning many different business projects or departments.

Suppose you've created a spreadsheet to calculate your return on investment from a rental property. Timberline lets you compare this model's results with those from a stock-portfolio spreadsheet—even as you're creating the latter. To set up the comparison, you'd move the cursor to the desired cell and type something like +FILE (DATA, INVESTMENT, ,14,4). This would instruct the program to search for the worksheet named Investment, retrieve the value found in row 14, column 4, and enter it in the active cell of your

At a Glance

Name: Timberline Spreadsheet Calculator

Type
Spreadsheet

Manufacturer
Timberline Software
7180 South West Fir Loop
Portland, OR 97223
(503) 643-9461

Price
$395 for single-user system
$100 for optional Starter System package

Format
5¼-inch floppy disk

Computer
IBM Personal Computer; Digital Equipment Corporation Professional 350; Texas Instruments 200 and 300 series; Sage II

Documentation
95-page tutorial; 168-page reference manual

Audience
Anyone interested in spreadsheet calculations or financial modeling

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Robert Moskowitz is a business consultant who lives in Woodland Hills, California.

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stock-portfolio spreadsheet.

While we're on the subject of loading data, most spreadsheet programs require you to load an entire file at a time and position the data starting at row 1, column 1. With Timberline, you can bring just part of a file into active memory and place it anywhere you like. Timberline's selective loading lets you build complicated spreadsheets in small, manageable pieces and then merge them virtually any way you choose.

Honorable Mention

Sometimes a program's less obvious assets are the sweetest of all. It would be positively criminal to overlook these Timberline pluses:

- A constant display that lets you know approximately how many more grid cells you can fill before you run out of memory. On a 64K-byte machine, you start with about 950 cells and work downward; with 128K-byte memory, you have a whopping 2000 cells at the outset. (Unlike some of its competitors, Timberline doesn't abort when you run out of memory. The program simply locks up, forcing you to delete old entries to make room for the new.)
- Timberline offers two levels of data security. The first is the datafile password. When you save a file, you can link it to a password such as Thor or Groucho. Once you add the password, that file cannot be loaded, erased, or resaved unless someone types in the magic word. You can also "lock" data by cell, row, or column. If the bottom line is all that really intrigues you, you can lock that row and keep it safe from accidental erasure.
- Like some of that fancy "integrated" software that's hitting the market now, Timberline lets you sort rows and columns either alphabetically or numerically, in either ascending or descending order. In short, your most productive sales representative winds up on top after a quick sort of the sales column. And Timberline doesn't let the sorting foul up any of your carefully constructed formulas that link one cell to another.
- Timberline has plenty of built-in mathematical functions (logarithm, sine, cosine, random-number generator, and the like) that you play around with on the Edit line before entering a value into any given cell.
- The program has prompts that are direct and easy to understand. Examples: "Select area of the worksheet to be affected." "Protect this data?—Yes or No." Mercifully, there's no William Styronesque wordiness in any of the prompts.

Timberline Spreadsheet Calculator was developed under the UCSD (University of California, San Diego) p-System. To run the package, you must have the UCSD p-System *runtime* program. This program is available from Timberline as part of the Starter System ($100), which includes additional information and aids for users of the Timberline series of software products.

Frankly, I'm impressed with Timberline Spreadsheet because it's not trying to be a grandiose Calc-To-End-All-Calcs. If you're looking for a spreadsheet program that will also handle your business graphics and prepare Eggs Benedict in the morning, this ain't it. Timberline is a superior spreadsheet with crystal-clear documentation—period. I just wish they'd replace the Thor Heyerdahl quote with something snappy from Blaise Pascal. ☐

GAMES

Sea Dragon

A submarine mission guaranteed to test your nerve and dexterity

by Arthur Granville

"Dive, dive," I screamed. "Get 'er down!" Panic had stripped away my pose of self-assured command. Terror clawed at my gut as our sub bore down on the bristling mine.

"Take it easy, Dad," she said coolly. "When you're in the middle of the screen, you can just pull the joystick back and wait for the mine to float up in front of you. See?" One push of the torpedo button and—blam!—she blew it out of the water.

Nine-year-olds show a lot more composure in video combat than their fathers do. I think most of us lose our nerve as we age, victims of too many missions on the freeway, too many showdowns over the conference table. I had spent hours trying to steer the U.S.S. Sea Dragon through enemy waters to find and destroy the Master Mine. All I had to show for it was crabbed hands and the sense of defeat that comes from going down with your ship roughly 500 times. My daughter, on the other hand, quickly learned to thread mine fields, weave through treacherous undersea corridors, skirt depth charges, and dodge the laser weapons that stood in the way of victory. Her older brother and all their friends showed similar poise, to my chagrin.

They loved the game and played it tirelessly. Even I, in the depths of battle fatigue, had to admit that it presented a colorful challenge that kept me coming back to try again. In a word, it's fun. Not an educational breakthrough, not handy in the kitchen, just plain fun.

The Game's Design

Sea Dragon's Atari version, the one I tested, is for one or two

---

Arthur Granville is a freelance writer who lives in Ypsilanti, Michigan.

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players; a joystick is required for each player. On the Apple and TRS-80 versions, joysticks are optional; the Apple version is designed for one player only. The program is written in machine language, which makes for rapid screen action and quick response to the player's motions at the helm.

The submarine begins its voyage on the left side of the computer screen, where it rests just beneath the surface of a blue, blue ocean. Sonar burbling, the sub sets out over the peaks, valleys, and plateaus of the ocean bottom. Stretching across the bottom is a nasty strip of mines. Some of them ride on the end of tethers that are anchored to the floor; others detach themselves and bob upward as the sub passes over. During this journey the scenery scrolls smoothly across the screen. The image is like what you'd see through a camera panning from left to right as it follows the sub's travel. You, the captain, control forward speed and depth, dodging the mines or detonating them with a limitless supply of torpedoes.

If you survive this part of the run, you'll find yourself entering a twisting course of undersea caverns defended by laser rays. Then you'll emerge into open sea again where surface ships wait with depth charges. This trial of courage continues for 30 full screens of battle—enough to tax Ulysses, surely. If your luck holds, you'll face the final test: destroying the heavily guarded Master Mine. Even skippers are allowed a few mistakes, though. You can lose four subs and still carry out your mission with the fifth, but that's your last chance.

Points are scored by blasting the enemy's various weapons with your torpedoes. A running tally is kept for each player at the top of the screen, alongside the all-time high. If the record is surpassed, the new high score is written on the disk at the end of the game.

You can choose to play at any of four skill levels. The sub's speed increases with each level. At top speed the images flow by like scenery viewed from a train window. This level of the game is apparently designed for those who have grown bored with Grand Prix race driving.

Graphics, Sound, Action

Built into the Atari computer are some special chips for programming sound and graphics that Russ Wetmore, the author of the Atari version of Sea Dragon, has put to good use. He has combined bright colors, simple cartoons, clever sound effects, and cinematic motion to create a display that's entertaining even if you're just looking over someone's shoulder. When I first tried out the program in a computer store, I soon had a sizable audience of customers watching. Visually, Sea Dragon is reminiscent of *Yellow Submarine*, the animated movie set to Beatles music. I don't draw that comparison just because of the submarine motif but because Sea Dragon is . . . well, *cute*. Is this a strange way to describe a war game where you have to blow up the other guy before he blows you up? Maybe so, but the surrealism of the game is part of its charm.

Caveats

I haven't tried the Apple or TRS-80 versions of Sea Dragon, but they are bound to differ from the Atari version. The Apple II lacks a sophisticated sound generator, for one thing, and the TRS-80 Models I and III can't display color. But the Sea Dragon programs for these machines may well have compensating features.

The only fault I found with Sea Dragon was not in the program but in the instructions that came with it. They seem to have been written by the same person who, I'm convinced, writes all the manuals for Japanese digital watches. The style is unmistakable: microscopic print, misspelled words, typographical errors, and teasing half-clues on how to make the thing work. Fortunately, the program itself provides all the guidance you'll really need. My advice is to read the instructions *after* you've played the game.

In case you do read them, one point needs to be clarified. Page 2 implies that you can place a write-protect tab on the disk to keep the disk drive from recording each new record-high score. Page 4, however, contradicts this with a dark warning against using a write-protect tab. I checked with the publisher and learned that it is okay to protect your disk with a tab if you don't mind losing the score-saving feature. Some owners might want to take this precaution to guard against accidental

At a Glance

Name: Sea Dragon

Type
Submarine combat game for one or two players (one player only on Apple II)

Manufacturer
Adventure International
Box 3435
Longwood, FL 32750
(305) 862-6917 or
(800) 327-7172

Price
$34.95 for Apple, Atari, and TRS-80 Color Computer versions; $24.95 for TRS-80 Models I and III version

Format
Cassette tape or 5¼-inch floppy disk (tape version not available for Apple II)

Computer
Apple II and IIe with 48K bytes of random-access memory; Atari 400 and 800 with 32K bytes (for disk version) or 16K bytes (for tape version); TRS-80 Models I and III with 32K bytes (for disk version) or 16K bytes (for tape version); TRS-80 Color Computer with 32K bytes (for tape version) and Extended BASIC; one or two joysticks required for Atari, optional for Apple and TRS-80

Documentation
4-page pamphlet

Audience
School-age and older fans of arcade-style games

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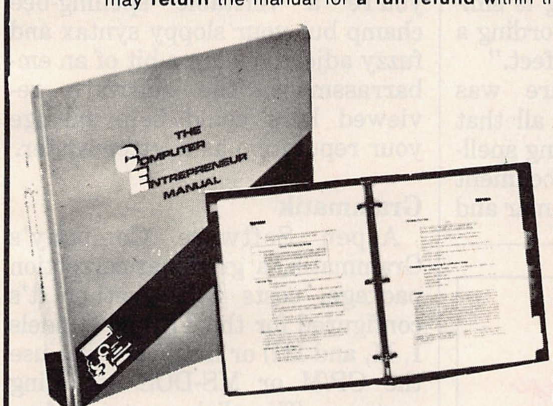

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destruction of the disk's contents.

Conclusion

I could carry my role as critic to extremes by wishing for a more realistic submarine simulator or a more plausible war game. That wouldn't be fair, though, because Sea Dragon doesn't pretend to be either of these. It's styled as an arcade game, pure and simple. It's a colorful and demanding test of dexterity and cunning that should provide durable entertainment. I can't imagine anyone getting so good at Sea Dragon that it would lose its challenge. What's more likely is that some people . . . I might as well come out and say it . . . some *adults* will find it too challenging even at its easiest level and give up in frustration. But then they can do what I do: turn the controls over to the kids and take a lesson in nerve from some seasoned video veterans. □

WORD PROCESSING

Add Luster to Your Letters

Clarify your correspondence with grammar-correcting software and a disk thesaurus

by Terry Kepner

Office-efficiency surveys show that word processors seldom reduce the amount of time a business spends on correspondence. In some offices, the time saved in retyping is simply spent revising and rewording a document so that it's "perfect."

Spelling-checker software was supposed to cut down on all that fiddling around, but checking spelling is only a small part of document revision. Cleaning up grammar and searching for apt synonyms is much more time-consuming. Though outnumbered by the spelling checkers, grammar-correcting software and thesaurus packages are starting to find a market. If you're a veritable spelling-bee champ but your sloppy syntax and fuzzy adjectives are a bit of an embarrassment, the software reviewed here could help salvage your reputation as a letter writer.

Grammatik

Aspen Software Company's Grammatik, a grammar-correction package, costs $75 whether it's configured for the TRS-80 (Models I, II, and III) or machines that use the CP/M or MS-DOS operating systems. The disk contains four machine-language programs—two that analyze your document and two that maintain Grammatik's phrase dictionaries.

Grammatik searches for grammatical gaffes and goofs as outlined in *The Chicago Manual of Style* (University of Chicago Press, 13th ed., 1982), *The Elements of Style* by Strunk and White (Macmillan, 3rd ed., 1978), and several other highly regarded style books.

Specifically, Grammatik checks your document for archaic and outdated words; capitalization errors; unbalanced parentheses, quotes, and brackets; and doubled words ("the the") and subtler redundancies ("join together"). The program also screens for brand names used generically ("Kleenex") and common grammatical mistakes ("must of" in lieu of "must have"). You can

Terry Kepner is a freelance writer and software consultant in Peterborough, New Hampshire.

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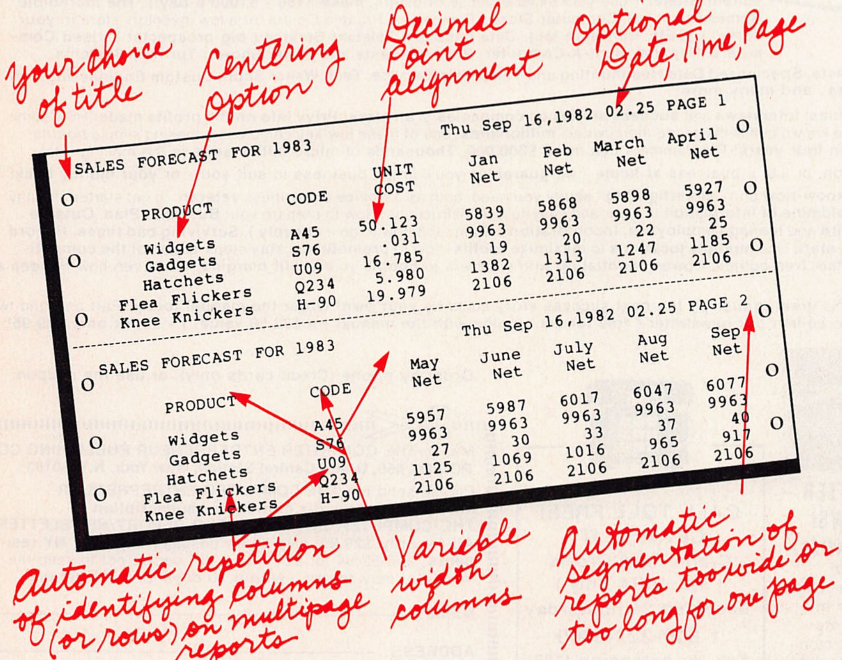
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     PRODUCT         CODE      COST      Net     Net     Net     Net

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  Hatchets           U09      16.785      19      20      22      25
  Flea Flickers      Q234      5.980    1382    1313    1247    1185
  Knee Knickers      H-90     19.979    2106    2106    2106    2106
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                              May     June    July    Aug     Sep
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even create new categories if these don't seem nitpicking enough.

Grammatik's phrase dictionaries are easy-to-alter ASCII files. The most unusual is the dictionary of sexist terms—ideal for writers who want to weed out words like "chairman" and "businessman."

After Grammatik's first pass at your document, you'll get a display revealing the total number of words in your opus, average word and sentence lengths, the number of questions and imperatives, the number of sentences with 14 words or less, and the number of sentences with 30 words or more. You'll also be apprised of the length and location of your document's shortest and longest sentences, the number of "to be's" and prepositions, and more.

Grammatik does have its minor flaws. The menu has no bail-out option; to leave the menu you must either begin processing your file or press the reset button. In addition, Grammatik's documentation doesn't adequately explain the significance of all its word-length and sentence-length data. You're not told, for example, that if the ratio of "to be's" to sentences approaches the number 1, you should revise some of your document's verbs. The documentation also neglects to inform you that correspondence designed for average readers should contain words that average 4.7 characters in length, as stated in one of the corollaries of the Fleschman readability test.

Another problem with Grammatik is that it's programmed primarily for lowercase errors. If the error is a combination of uppercase and lowercase letters, the program will probably miss it. And if you're using decimals in the document, any decimal point followed by a space and a capital letter (or line space) is treated as the end of a sentence.

But Grammatik's programming sins are something I can easily live with. The first time I loaded a document for Grammatik's scrutiny, I must confess I was terrified. What writer wants to have a machine conclude that he's sloppy and redundant? Although the computer didn't mock me, I felt sheepish when I saw the display: my 3658-word story contained only 926 different words. I had used the word "able" only once, while the word "the" popped up 253 times.

Until the grammarians invent another article to accompany "a," "an," and "the," though, I'll simply have to be redundant and proud. Grammatik may not turn you into Norman Mailer overnight, but it will rid your business letters of bonehead grammatical errors.

Refware Thesaurus

Although the name Refware conjures mental pictures of fashion shows for basketball officials, it's really a thesaurus-on-a-disk. In fact, Refware Thesaurus Version 2.0 is the biggest innovation in the thesaurus business since Peter Roget first got the bright idea to group synonyms back in 1852.

But is Refware's Thesaurus genuinely practical? Although this 5¼-inch floppy disk contains 24,800 words, will TRS-80 Models I and III users find the program handier than the umpteenth edition of Roget's classic? I don't think so.

Here's how the program works:

After booting Thesaurus (48K-byte random-access memory and two disk drives needed), you'll get a prompt asking you the word you're seeking synonyms for. The software then displays nine synonyms; the average search time is about seven seconds per word.

Thesaurus even inserts these synonyms in the very sentence that has you stumped. For example, you can type, "The missile gap is closing." After entering the word "gap," you'll get a screen display like this:

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The missile hole is closing.
The missile interstice is closing.
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the American/Soviet missile interstice?

The Refware Thesaurus Builder ($149.95) functions similarly to Thesaurus 2.0, except that you control dictionary entries and word groupings. Because it's virtually impossible to find a hard-copy thesaurus that is customized for a particular profession, this package can be quite valuable. In the computer field, for instance, we magazine writers could use Thesaurus Builder to type in the overworked word "user" and get some stolid synonyms such as "operator," "owner," and "you."

So far so good, but every time I'm writing at the terminal and discover I need a synonym, I have to save my file, remove the word-processor disk, load BASIC, and load Thesaurus to go looking for a replacement word. This song and dance takes longer than thumbing through a hard-copy thesaurus.

The most practical way to use the program is to write your first draft with the word-processing program and mark the words you want replaced with an asterisk. Then you print the document, load BASIC and Thesaurus, and search for replacement words every time you spot an asterisk.

Another disadvantage is that these disks are about 25,000 words shy of the 50,000 words found in the average thesaurus. Fortunately for Refware, research indicates that most people have a working vocabulary well below this number, making it probable that you'll find the word you want among the 24,800 included on the disks.

The documentation supplied by Refwar is well written and takes you through the operation of the programs step by step. The programs themselves are easy to use.

Some TRS-80 users will enjoy the novelty of Thesaurus and Thesaurus Builder, while others will howl about the price—more than 10 times the cost of a Roget paperback. If we could somehow beam Peter Roget into our decade, I'm sure he'd find a word for Refware's thesaurus-on-a-disk: silly, not to mention fatuous, absurd, ludicrous, ridiculous . . . □

At a Glance

Name: Grammatik

Type
Grammar-correcting software

Manufacturer
Aspen Software Co.
POB 339
Tijeras, NM 87059
(505) 281-1634

Price
$75

Format
5¼- or 8-inch floppy disk

Computer
TRS-80 Models I, II, and III; Apple II, IIe, and III with CP/M card; IBM Personal Computer; Osborne 1; and other CP/M- or MS-DOS-based systems

Documentation
32-page manual with index

Audience
Business and home users who want grammatically correct correspondence

---

Name: Thesaurus (Version 2.0) and Thesaurus Builder

Type
Disk-based thesauri

Manufacturer
Refware
POB 451
Chappaqua, NY 10514
(914) 238-8896

Price
Thesaurus Version 2.0: $89.95
Thesaurus Builder: $149.95

Format
5¼-inch floppy disk

Computer
TRS-80 Models I and III

Documentation
24-page manual (Thesaurus 2.0)
96-page vinyl loose-leaf binder (Thesaurus Builder)

Audience
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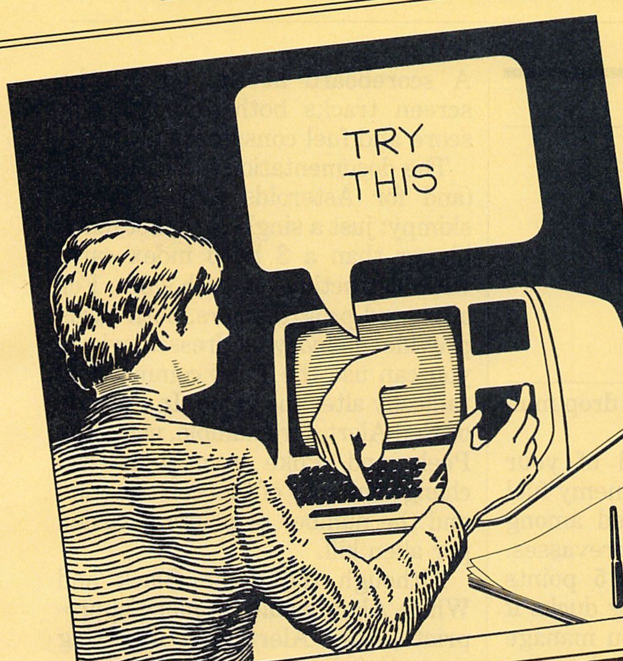

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GAMES

Two Shoot-'Em-Ups for the Timex/Sinclair

Good graphics are essential when you don't have sound or color

by Dan Brin

If you were one of this country's biggest retailers of Timex/Sinclair software, would you accept the challenge of marketing 16K-byte versions of two popular arcade games for computers that offer no sound or color? Apparently the folks at Softsync Inc. believe that sensory deprivation won't hurt the sales of Red Alert (based on the arcade hit Scrambler) and Meteorites (spawned by the arcade classic Asteroids). However, most Sinclair users—even those familiar with the arcade predecessors—will prefer the clever Red Alert to the chaotic and confusing Meteorites.

The object of both games is to amass points by destroying things—period. Neither game offers you princesses to rescue or wookies to befriend or treasures to win. I'll start my analysis with Red Alert just because it nettles you with the most post-game humiliation (it flashes your final score alongside the highest score notched during that session).

After loading the Red Alert cassette, you'll see your spaceship—an object that looks like a submarine with a bad back—cruising over a landscape of randomly generated, ziggurat-like mountains, plateaus, and valleys. Actually, the landscape moves from right to left under you, so up and down is all you've got for evasive action. Needless to say, your fingers pressing the 6 and 7 keys to effect this vertical dodging get a real workout. Your free fingers must simultaneously fire fusillades of hyphens (missiles) and drop multiplication signs (bombs).

On the receiving end of your missiles and bombs are enemy fuel tanks and rockets nestled among the mountain peaks and crevasses. The fuel tanks, worth 15 points each when hit, are sitting ducks if your aim is good and you manage to avoid crashing into looming peaks. The rockets, however, can fly up and nail you at times you can never predict. They're worth five points apiece when hit.

If that's all there were to the game, you'd probably find yourself skimming the surface like Slim Pickens' B-52 in *Dr. Strangelove* and carpet bombing everything in sight. But for added challenge the programmers provide aliens that come at you from right to left in sorties of one to five. Represented by less-than signs, aliens fly in a dangerous wavy pattern, firing dashes at you and generally making life difficult in the upper altitudes. You can avoid these villains by flying low, but after playing the game awhile, you'll want to develop ways to challenge them.

I taunt the aliens with hit-and-run techniques. When I'm not carpet bombing fuel tanks and strafing rockets, I bop up to the top of the screen and lay in wait for the attackers. The moment they appear on the screen, I fire my missiles and simultaneously drop altitude, thereby releasing a devastating staggered barrage at five different levels and dropping out of danger at the same time. An awesome combination.

You get three ships per game, unless, of course, you run out of fuel while skippering the first two. A scoreboard at the top of the screen tracks both your current score and fuel consumption.

The documentation for Red Alert (and for Asteroids too) is pretty skimpy: just a single card, not much bigger than a 3 by 5 index card, with instructions on both sides. For advanced programmers, both cards provide memory addresses where you can use the Peek command to radically alter the game. In the case of Red Alert, for example, using the Peek and Poke commands can change the rate of fuel consumption and the number of points awarded per alien kill.

Although the name Black and White Alert would be more appropriate, Red Alert is a diverting game that lets you vent hostilities just as well as its flashier arcade counterpart.

An Asteroids Look-Alike

Meteorites, not surprisingly, gives you the opportunity to blast space rocks, a pursuit that can quickly turn into a real snore. Personally, I much prefer games like Red Alert, where I can fantasize about sputtering, cursing aliens going down in flames.

Meteorites' documentation sets the stage for something much more thrilling than what the program delivers: "You are the only person who has flown the Svlegian Raider. You sit back, the seat molds around you, and you blast toward the alien asteroids. Prepare yourself—you're about to enter a meteorite field."

A lovely picture of said Svlegian Raider, blasting the bejeebies out of some oncoming cosmic real estate, graces the documentation card. But upon loading the program, you see a black field with a white numeral in the center of the screen. Suddenly two enormous blobs of pixel-clusters appear at the corners of the screen, then move steadily toward the numeral.

You suddenly wise up, realizing that the numeral is your Svlegian Raider. Moreover, the numeral's value represents the direction in

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Dan Brin has written for the *Los Angeles Times* and the Heritage Southwest Press newspapers.

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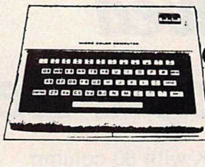

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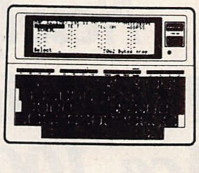

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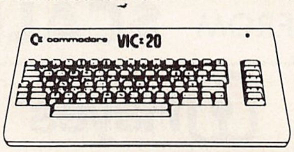

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Circle 30 on inquiry card.

which the Raider points. A 4, for example, means the Raider is firing straight down; a 1 indicates that you're pointing and firing toward the upper right-hand corner of the screen. Meteorites is an improvement over Red Alert when it comes to mobility (it even has a Thrust key to move you out of harm's way quickly), but I wanted a *craft* to command, not some mutating numeral!

When you hit one of the lumbering blobs, it immediately breaks up into four smaller meteorites. These in turn disappear from the screen when hit. If you successfully exterminate the eight meteorites chipped off the original two, three more of the big blobs converge, and the whole splintering process begins anew. If you survive this round, you face only one more assault—this time from four pixel-blobs that turn into 16 faster meteorites.

The game gives you three Raiders in succession to work with. The number of ships remaining and your running score are listed at the top of the screen. And what's your reward for cracking the 10,000-point mark? Why, a bonus ship, of course, and a chance to play the game in reverse video—screen white, numeral black. Not exactly the kind of "reward" that would send Luke Skywalker hurtling through the heavens.

I racked up 20,500 points in one game simply by staying in the middle of the screen and firing blindly in all directions. I'm sure I could have scored even higher had I employed some strategy, but what's the point? If I pilot my numeral craft past 45 chunks of space debris, I deserve a better reward than getting to play a bit longer in reverse video.

If you're the type of computer gamester who feels that running up a high score is intrinsically pleasurable, both these Timex/Sinclair offerings will appeal to you. Red Alert has by far the more imaginative graphics, however, and I predict it'll be the bigger hit. Anyone who disagrees probably has space rocks in his head. □

At a Glance

Names: Red Alert 16K
and Meteorites 16K

Type
Entertainment

Distributor
Softsync Inc.
14 East 34th St.
New York, NY 10016
(212) 685-2080

Price
$14.95 each

Format
Cassette tape

Computer
Timex/Sinclair 1000 or Sinclair ZX81 with 16K bytes of random-access memory

Documentation
Small instruction card

Audience
Sinclair users who enjoy action computer games

BUSINESS

Information Master

Database management for the Apple II

by Rosemarie Gabriele

Every small-business or self-employed professional has to keep extensive records of financial transactions, client information, mailing lists, and other critical data. The microcomputer software industry has spawned a wide variety of database-management and report-generation programs to meet this need. Information Master and its companion program Data Master, from High Technology Software Products, are two such products that provide a useful and flexible database-management system for the Apple II.

The first program, Information Master, is a well-designed record-keeping and report-writing package that gives you the freedom to design and manipulate your own unique records and reports. Rather than adapting an already formatted file that wasn't exactly what you wanted in the first place, you can create customized forms. Because the program is fully menu-driven, it is easy to learn and use. After working only a few hours with the tutorial manual, you'll be ready to design a report format and enter data.

To understand the function of Information Master, you can compare it to a conventional file cabinet. Think of the individual folders as "records" and the information contained in each folder as made up of "fields." A drawer full of folders corresponds to a disk full of files.

With a file drawer in front of you, you can pull out the individual folders. It works the same way with a disk. Instead of pulling a folder out of the drawer, you obtain information by typing the file's title. For example, if you're a teacher, the first record in your file might contain: field 1 (line 1), the student's name; field 2 (line 2), the student's address; field 3, the student's birthdate; field 4, the student's grade; field 5, the student's math scores; and so on. Subsequent records could contain similar information about different students. On the other hand, if you own a small business, your records might be broken down by month. For each record, field 1 might contain your telephone expenses; field 2, utility bills; field 3, advertising expenditures; and so on.

The program has fixed limits on the number of records, fields, and characters it can handle: up to 1000

Rosemarie Gabriele is a freelance writer and runs a computer club in Stamford, Connecticut.

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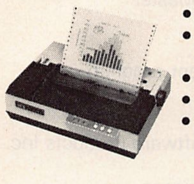

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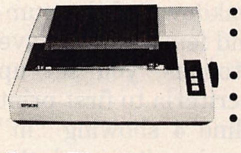

- 100/160 CPS
- Dot graphics
- Proportional spacing
- Super/subscript
- Underlining
- Downloadable character sets

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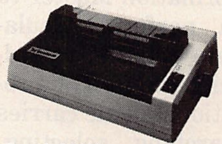
Epson RX-80	

Star Micronics Gemini 10X/15



- 100 CPS
- 120 × 144 dot graphics
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- Super/subscript

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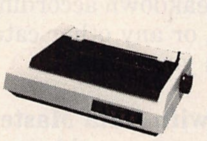

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- Text justification

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IDS Prism

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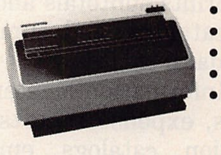

- 200 CPS
- 24 × 9 dot matrix
- Color graphics
- Text justification
- Proportional spacing

Model	List	Price
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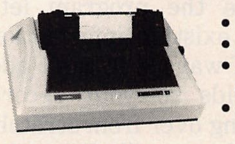
The Bufferboard	$175
Orange Board Parallel Interface	$ 87

Anadex Silent Scribe

The Quiet Matrix Printer



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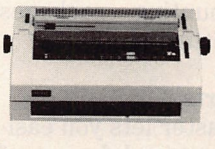

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- Bi-directional printing
- Quiet, efficient operation for word processing

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records per disk with 20 fields per record and 99 characters per field. Thus in field 1 you can use up to 99 spaces for the student's name and in field 2, up to 99 numbers and letters for the address.

After you have decided on the kind of files you want to create and have added your data to these files, you can use Information Master to reorganize data, perform calculations, or generate reports according to your specifications. The program's organizational mode carries out sorting, searching, selecting, alphabetizing, scheduling, and indexing. The calculation mode can do addition, subtraction, multiplication, division, exponentiation, and summation. The report mode generates and prints subtotals and totals, labels, catalogs, and summaries of your data.

You can use Information Master for mailing lists, expense reports, client information, catalogs, employee records, stock market reports, class rosters, or inventories—to name a few possibilities. Although the program can also perform simple accounting tasks, specialized accounting packages probably do a better job.

Preparing Reports

Information Master lets you easily vary the content and format of your reports and generate a number of different reports using the same data. And it's this capability that makes Information Master a valuable tool. For example, suppose you're a surgeon who performs a number of different kinds of operations each year. You might set up a data structure as follows:

Line 1: patient name
Line 2: street address
Line 3: city, state, and zip code
Line 4: male or female (m or f)
Line 5: patient's date of birth
Line 6: date of operation
Line 7: type of operation

If you want to know how many appendectomies you performed during the past year, you can create a set of selection criteria to print or display the appropriate files. In this case you instruct the program to select all files for which line 7 reads "appendectomy" and keep track of the total number of files selected. Information Master then prints or displays each file and tells you how many include an appendectomy.

To get a breakdown of the number of males and females who have had appendectomies, you set up your selection criteria to first print all files with line 4 showing "m" and line 7 showing "appendectomy" and then print all files for which line 4 shows "f" and line 7 shows "appendectomy." For a more sophisticated report, you could order a breakdown according to age, zip code, or any other category included in your format.

Revising Files with Data Master

Suppose you want to add some new information to your database, such as the fees charged for each type of operation. Here you'll run into a snag with Information Master. While the program lets you reformat existing information in a variety of ways, you can't add new data fields to your record without starting over from scratch. It's unlikely that you'll always include all the relevant information the first time you set up a data structure, so you're bound to run into this problem again and again. To solve it, you'll need Data Master, also produced by High Technology Software Products.

Data Master does what Information Master doesn't do. It lets you redefine a system layout; merge and subdivide files; combine, rearrange, or delete old fields; add new fields; and make a number of other format changes. Moreover, it accomplishes all this relatively quickly, without making you reenter any existing data.

Because business requirements change, you need a flexible program that can adapt to your changing needs. Once you begin to use the full capacity of Information Master, you are sure to need the added capability and convenience of Data Master. To avoid unnecessary frustration, I suggest you buy both programs at the same time.

At a Glance

Name: Information Master

Type
Database-management program

Manufacturer
High Technology Software Products Inc.
POB 60406
Oklahoma City, OK 73146
(405) 524-4359

Price
$150

Format
5¼-inch floppy disk

Computer
Apple II Plus, IIe, and III with one disk drive (two drives are preferred but not required)

Documentation
150+-page manual with tutorial

Audience
Anyone who needs to store information and retrieve it easily in a variety of report formats

Accessory Programs

Name: Data Master

Type
Database-management program that expands and manipulates files created by Information Master

Price
$100

Documentation
38-page manual

Name: Transit

Type
Utility program that transforms standard Apple files into Information Master files

Price
$50; Information Master and Transit may be purchased together for $189

Documentation
33-page manual

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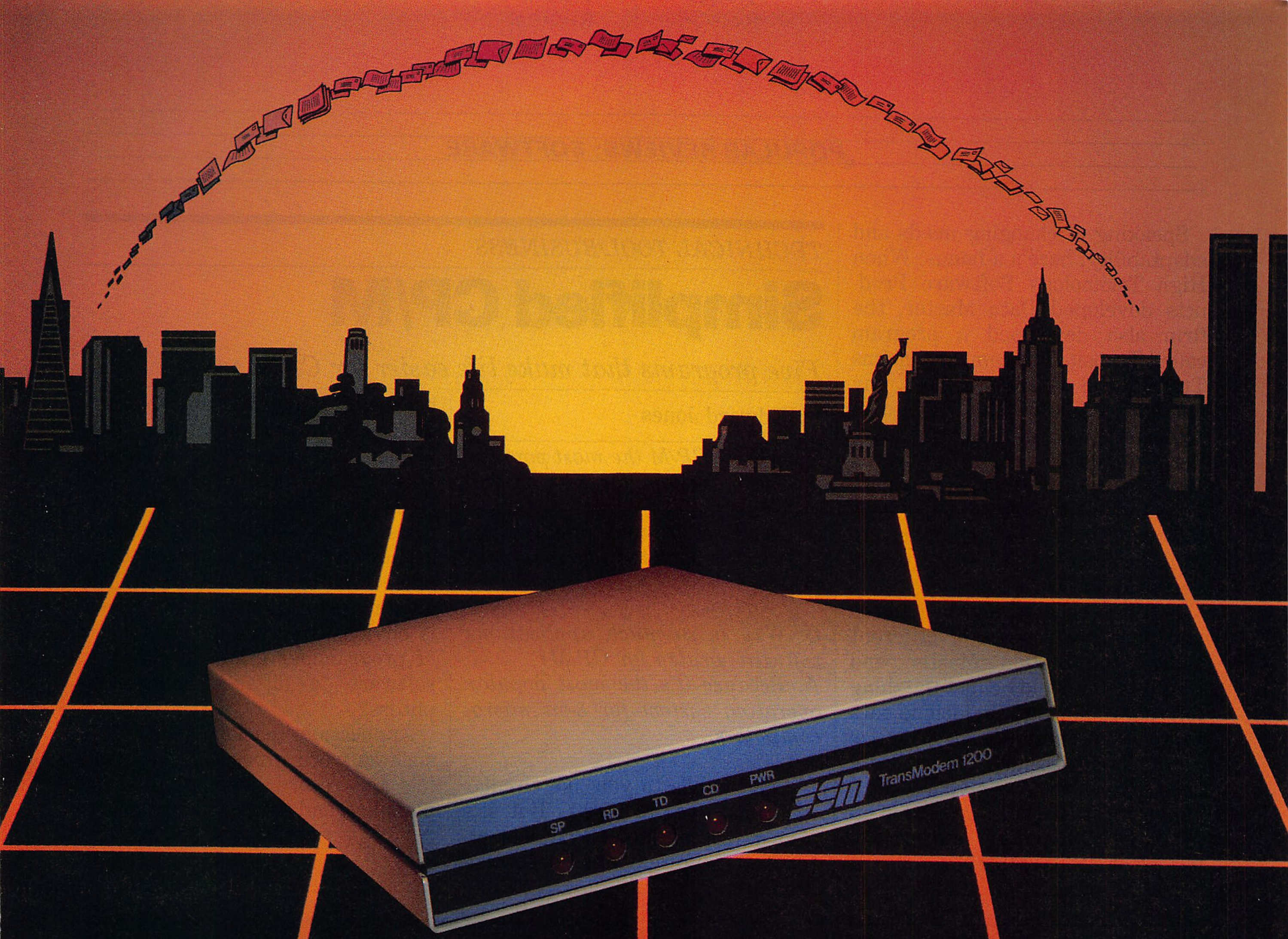

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Speaking of changing needs and adaptability, here's a bonus. When High Technology Software Products developed Data Master, the firm also developed a program called Transit. The company claims Transit can convert almost any standard Apple II data file into an Information Master file, including files created by programs such as Visicalc, Data Factory, and others. Like Information Master and Data Master, Transit is menu-driven, well documented, and easy to understand and use.

If you keep a variety of records and generate reports of different types, Information Master and Data Master could be just the thing for you. If you want to include data from other programs in your reports, Transit should be a useful time-saver. Whatever your needs, you'll find that these programs offer flexibility, power, and ease of use, all at a reasonable cost. □

TECHNICAL TOOL/BUSINESS

Simplified CP/M

Five programs that make life easier for CP/M users

by Edward Jones

Q. *Why is CP/M the most popular operating system for 8-bit microcomputers?*

A. *Because so much applications software is written to be used with it.*

Q. *Why is so much applications software written for CP/M?*

A. *Because it's the most popular operating system for 8-bit microcomputers.*

If that sounds to you like circular reasoning, you're right. But it's also a fact of life. CP/M has attracted applications software because it's available for so many different microcomputers. This means that the same software, with minor modifications to account for differences in disk formats or keyboard and display capabilities, can be made to run on any computer that uses CP/M. The advantage for a software developer is obvious: it saves literally years of programmer effort in adapting software to different microcomputers.

Applications packages for tasks such as word processing, accounting and record keeping, financial planning, and data communications

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Edward Jones is a freelance writer living in Dallas, Texas.

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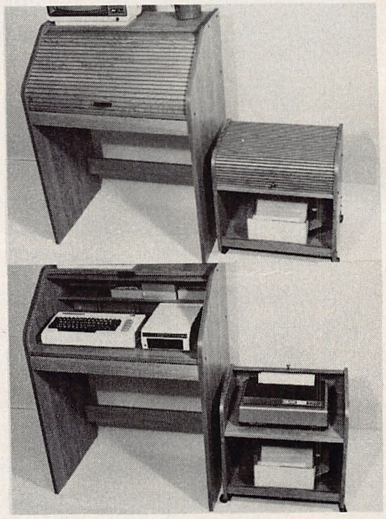

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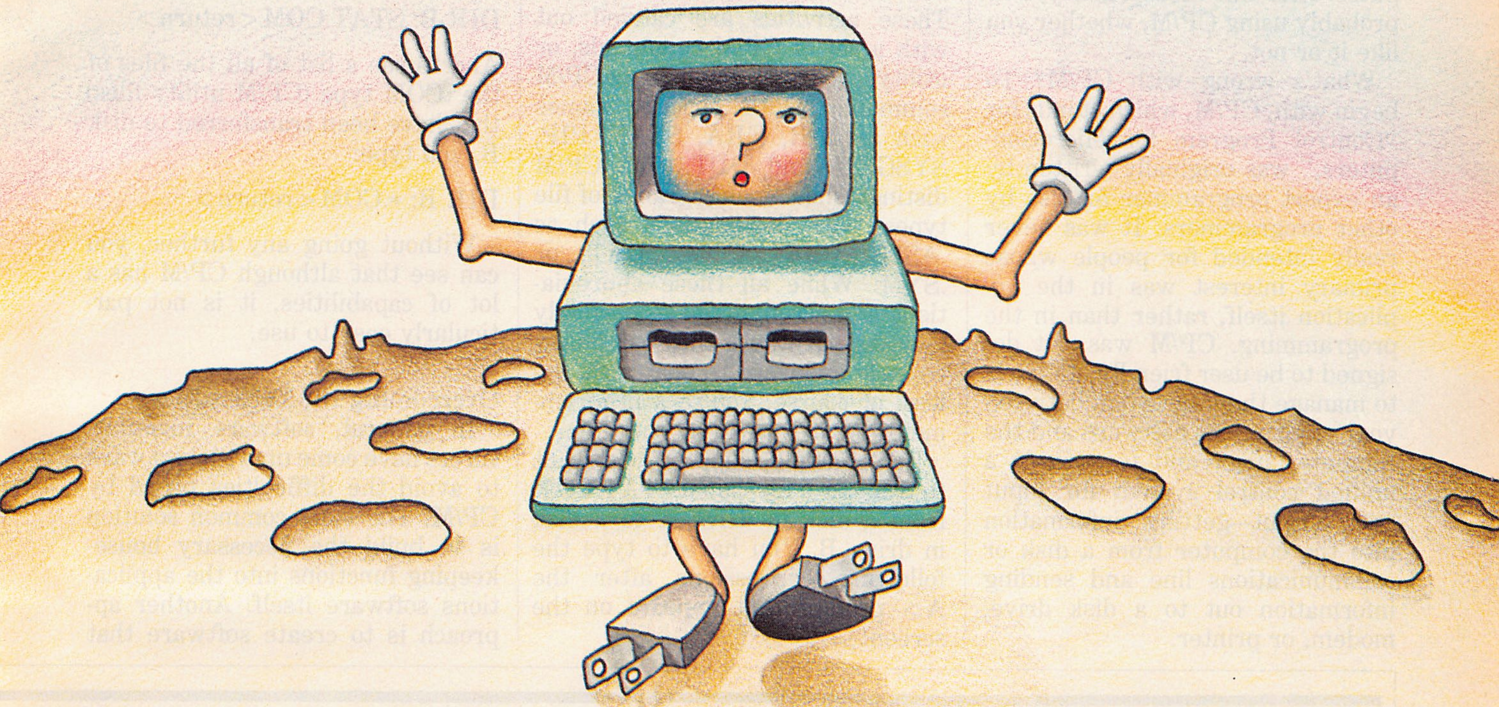
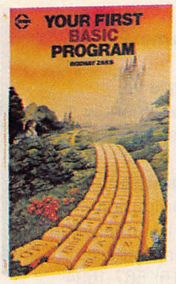


Your computer can probably do more for you than you originally thought. And learning to expand its capabilities is as easy as reading a good book.



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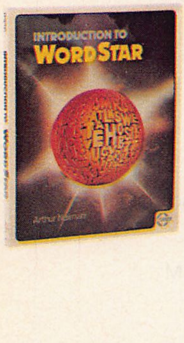

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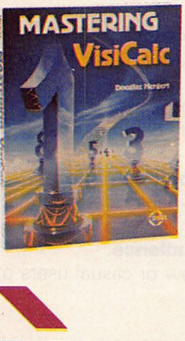

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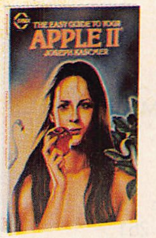

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are the bread and butter of computer use. If you're a typical computer user in a business or profession, chances are that one or more of these uses is your main justification for acquiring and using a computer. And this means that you're probably using CP/M, whether you like it or not.

What's wrong with CP/M? To begin with, CP/M, which stands for "Control Program for Microcomputers," was originally written by an expert programmer for use by other programmers. It was never really intended for people whose primary interest was in the application itself, rather than in the programming. CP/M was not designed to be user friendly; its job is to manage the interaction between your applications software and the computer itself and to provide a unified control system for input and output—getting information into the computer from a disk or communications line and sending information out to a disk drive, modem, or printer.

The CP/M operating system takes care of daily housekeeping chores such as initializing, formatting, and copying disks; erasing, copying, and transferring files; checking the amount of storage available on a disk; and so forth. These activities are carried out with a set of CP/M commands, or utility programs built from CP/M commands, with obscure names such as DIR, ERA, STAT, PIP, SYSGEN, and DDT. And CP/M distinguishes among a range of file types, with designations such as .ASM, .BAK, .COM, .DAT, or .SYM. While all these abbreviations and acronyms have perfectly logical derivations, they can be extremely awkward to deal with, unless, of course, you're a programmer who uses them all the time.

For example, suppose you want to transfer a file called STAT.COM from a disk in drive A to a disk in drive B. You have to type the following expressions after the A> prompt that appears on the screen:

```
PIP<return>
*B:STAT.COM=A:STAT.COM
  <return>
*<return>
```

To see if your file has been properly transferred you type:

```
DIR B: STAT.COM<return>
```

And to see a list of all the files of the .COM type (CP/M utility files) that have been transferred to disk B, you type:

```
DIR B: *.COM<return>
```

Without going any further, you can see that although CP/M has a lot of capabilities, it is not particularly easy to use.

Overcoming the Difficulties

In general, software manufacturers have come up with two ways to avoid the difficulties posed by CP/M. The most common solution is to build the necessary housekeeping functions into the applications software itself. Another approach is to create software that

At a Glance

Name:	CP+	Supervyz	Power
Type	User-friendly overlay for CP/M operating system	User-friendly overlay for CP/M operating system	User-friendly overlay for CP/M operating system
Manufacturer	Taurus Software Corporation 3685 Mt. Diablo Blvd., Suite 251 Lafayette, CA 94549 (415) 283-7222	Epic Computer Products Inc. 18381 Bandilier Circle Fountain Valley, CA 92708 (714) 964-4722	Computing Inc. 2519 Greenwich St. San Francisco, CA 94123 (415) 567-1634
Price	CP/M-80 version: $150 CP/M-86 and PC-DOS version: $200	$150	$169 (CP/M-80 and CP/M-86 versions)
Format	5¼- or 8-inch floppy disks	5¼- or 8-inch floppy disks	5¼- or 8-inch floppy disks
Computer	Any computer using CP/M	Any computer using CP/M	Any computer using CP/M
Documentation	116-page, tabbed reference manual and tutorial	70-page reference manual	120-page command reference handbook
Audience	New or casual users of CP/M	New or casual users of CP/M	New or casual users of CP/M

directly circumvents CP/M or helps someone learn to use it conveniently. In this review, I've examined five software packages aimed at making life easier for CP/M users: CP+ by Taurus Software, Supervyz by Epic, Power by Computing, Helpcom by Design Systems, and Stok Pilot by Stok Software.

CP+, Supervyz, and Power all provide a series of menus that let you perform CP/M operations without having to master an obscure command syntax. The other two programs, Helpcom and Stok Pilot, give assistance in a different way. Both create sequences of help screens and customized lessons for CP/M itself or for CP/M applications programs. Helpcom, for instance, provides a series of help screens with information about CP/M commands. Programs like Helpcom and Stok Pilot make a a lot of sense for people who want to use CP/M without most of the associated complexities, or to help others learn to use CP/M.

Using CP+

CP+ by Taurus Software is a menu-driven control program. It doesn't replace your applications software; instead, it lets you select from among the applications available on a given disk and perform all normal CP/M functions by using a series of five menus. When you start the program, the CP+ start screen offers choices that lead you into the different menus: select and run a program, print commands, file commands, review commands, change the user area, and exit to CP/M.

To enter any of the subsequent menus, you select a letter that corresponds to the choice you want, and a new screen appears. Some screens supply you with a lot of information and may be somewhat confusing at first. However, after you work with CP+ for a short time, the screen layouts become familiar.

A particularly strong feature of CP+ is a set of printing options that let you build a print queue,

Name: Helpcom

Type
Screen-writing software for computer-assisted instruction

Manufacturer
Design Systems Inc.
POB 12243
St. Louis, MO 63157
(314) 391-0450

Price
$95 (plus $5 shipping)

Format
5¼- or 8-inch floppy disks

Computer
Any computer using CP/M

Documentation
17-page reference manual

Audience
Experienced CP/M users and programmers

Name: Stok Pilot

Type
Computer-assisted instruction using the PILOT language

Manufacturer
Stok Software Inc.
17 West 17th St.
New York, NY 10011
(212) 243-1444

Price
$129.95

Format
5¼- or 8-inch floppy disks

Computer
Any computer using CP/M, MP/M, or TURBO-DOS

Documentation
76-page reference manual and programming tutorial

Audience
Experienced CP/M users and programmers

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that is, a list of files or documents waiting to be printed. Using a print menu, you can select from the various files or documents contained on a disk and store them in a list. When you choose the start-printing option, CP+ prints all the documents in the order selected. Also included with the print commands are a series of formatting options that let you choose page lengths, margins, and so on.

Installation of CP+ is simple; a separate chapter in the CP+ documentation leads you step by step through the installation procedure. The documentation itself is excellent—it's clear, easy to understand, and laid out in a logical series of tutorials that explain all features of the program.

The disadvantages of CP+ are the need to constantly read information from the disk to perform the functions you want and the large amount of disk space that the software requires. Because most screens used by CP+ have to be loaded separately from the disk, the computer pauses for 5 to 10 seconds between most operations. While this pause would be noticeably shorter on a system equipped with a hard-disk drive, I found it annoying.

The CP+ software occupied more than 170K bytes of memory on my disk, leaving only 42K bytes on the first drive for the applications programs. Although CP+ does let you run your applications software from either disk drive, many software packages recommend that you place the applications disk in the first drive and a file disk in the second drive. With CP+, it may become difficult to do so without changing disks often. I can't honestly recommend CP+ for a single-disk computer unless it has an unusually large amount of disk space. If you have two disk drives with adequate storage space and you value user-friendliness, you'll find that CP+ accomplishes its purpose.

Supervyz

Like CP+, Supervyz by Epic Software is a menu-driven program for selecting applications software and performing common CP/M commands. Supervyz enables you to copy, erase, and write-protect files and initialize disks. Unlike CP+, Supervyz does not offer extensive print options. It lets you print only a single document by selecting a print option and entering the name of the document you want printed. You protect files from accidental erasure by selecting the write-protect choice from the main menu, and you remove that same protection by using a write-enable function. Supervyz also performs a disk verification test that lets you check the condition of a particular disk.

In addition, Supervyz lets you modify its menu structure by adding the names of commonly used applications programs to the menu. Unfortunately, this handy option requires familiarity with some CP/M concepts—such as file names, extensions, user areas, and default drives—that the average user of Supervyz may lack.

Another advanced feature is a built-in version of the PILOT programming language, which allows experienced programmers to create custom-designed, interactive teaching menus. In this respect, Supervyz is similar to the Stok Pilot software, which I'll describe later. If you are already familiar with both CP/M and programming, you might find this feature useful for customizing a version of Supervyz for other, less experienced users. On the other hand, if you choose Supervyz as a way of making CP/M easier for yourself, you're unlikely to use this aspect of the program.

Like CP+, Supervyz uses a fair amount of disk space. Supervyz's programs and its five initial menus

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use 70K bytes. If you add your own menus, the total amount of disk space Supervyz needs increases accordingly, leaving less space on the disk for applications programs.

The documentation for Supervyz is easy to understand and extensive. It consists of two sections: the first is for novices and casual computer users, while the second addresses more advanced users and programmers.

Both Helpcom and Stok Pilot require some knowledge of CP/M and elementary programming.

Power

Power is a user-friendly program for CP/M similar to CP+ and Supervyz. However, Power does not provide extremely detailed screens filled with information, as do the two other programs. In return for less detail, though, Power is fast, easy to use, and occupies far less disk space than the other programs, requiring just 12K bytes of space to operate. With Power, you still have to type the common CP/M command names in the normal CP/M fashion. For example, to erase a file, you enter ERA, while you rename a file by entering REN. After you type a command name, Power displays a numbered list of all the files on your disk. You then enter the number that corresponds to the file you want, and Power handles the rest of the work. You can run applications programs from the menu. All common CP/M commands, along with a number of special-purpose programming commands, are available when using Power.

For me, Power's most impressive feature is its reclaim command. If you've ever accidentally erased a file (as I have), you'll appreciate the ease with which the reclaim command restores erased files to your disk.

Power's weakest point is its documentation, which mixes elementary concepts and commands with advanced machine-language subjects and often uses terms that are unfamiliar to many computer users. Fortunately, the simplicity behind Power does much to override the shortcomings of the documentation.

This software package is well suited to anyone who is already familiar with CP/M and would like to simplify its use. Power assumes a low profile; you don't notice any drastic differences in your system until you decide to perform a routine CP/M operation. That's when you'll see just how effective this program is.

Helpcom

The Helpcom software package has two significant features. First, it offers a series of screens that explain the use of common CP/M commands, along with a complete description of CP/M, a list of common control-key functions, and a glossary of CP/M terms. All this makes Helpcom like a textbook on a floppy disk that explains the use of CP/M.

This feature alone, however, would not make Helpcom worthwhile. The program's ability to create help screens for any given application is what makes this program valuable. Helpcom is basically a CAI (computer-assisted instruction) program that lets you create displays of up to 23 lines of information on your computer's screen. If, for example, you needed explanations for the office staff on how to use an accounting package, you could create a number of pages of text (using any word-processing package) and combine that document with a help file that is part of the Helpcom package. Inexperienced users could then type in "help" and select from a menu the choice that corresponds to the information they need.

Stok Pilot

Like Helpcom, the Stok Pilot program lets you create screens of information to help novice computer users. Stok Pilot is actually a version of the PILOT (Programmed Inquiry, Learning Or Teaching) language, which was developed for computer-assisted instruction. Stok Pilot goes one step farther than Helpcom: it lets you create numbered menus, ask questions, evaluate responses, and display different answers depending on the choices made by users.

If this sounds to you like programming, you're absolutely right. Stok Pilot lets you create an interactive teaching program for CP/M or, in fact, for any subject at all. Stok Pilot's commands cause specific actions to take place within a CAI program, and you have to understand programming to use the commands effectively.

Neither Stok Pilot nor Helpcom is designed for novices. Both programs require some understanding of computer operation, CP/M use, and elementary programming. The documentation for both packages delves heavily into concepts such as altering system files and calling assembler programs. Someone who is comfortable with the use of assembly language and the structure of BASIC programming will feel far more at ease than will a new user attempting to use either of these programs.

In Conclusion

Each of these programs fits a particular niche and can help the CP/M user. If you want to simplify the use of CP/M, then CP+, Supervyz, or Power deserve consideration. If you're an experienced computer user who wants to create a unique information package to assist other users, then Stok Pilot or Helpcom can serve as an instructional tool. If you're already experienced in the use of CP/M, you'll have to decide whether the tradeoffs in disk space and speed when using one of these programs are worth the benefits. □

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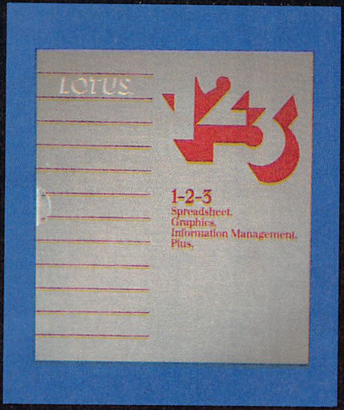

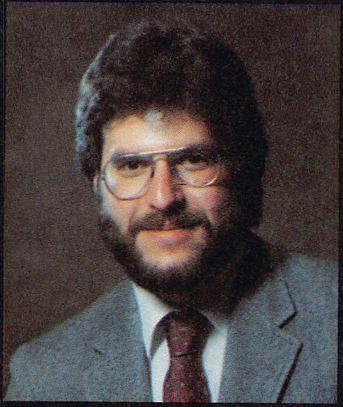
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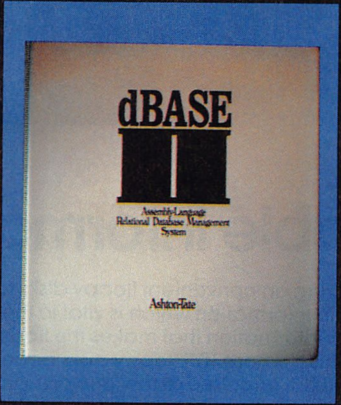

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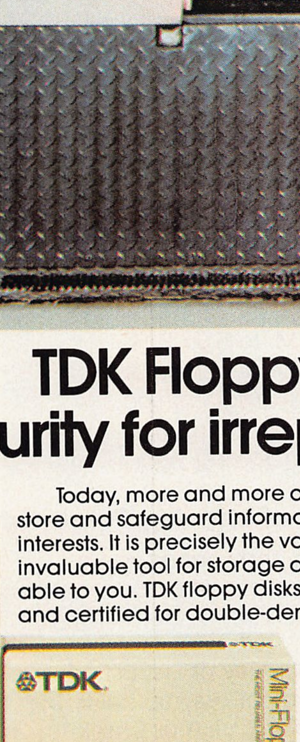

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The Psychic Computer

A program that guesses your secret number, plus a way to find prime numbers.

by Michael W. Ecker

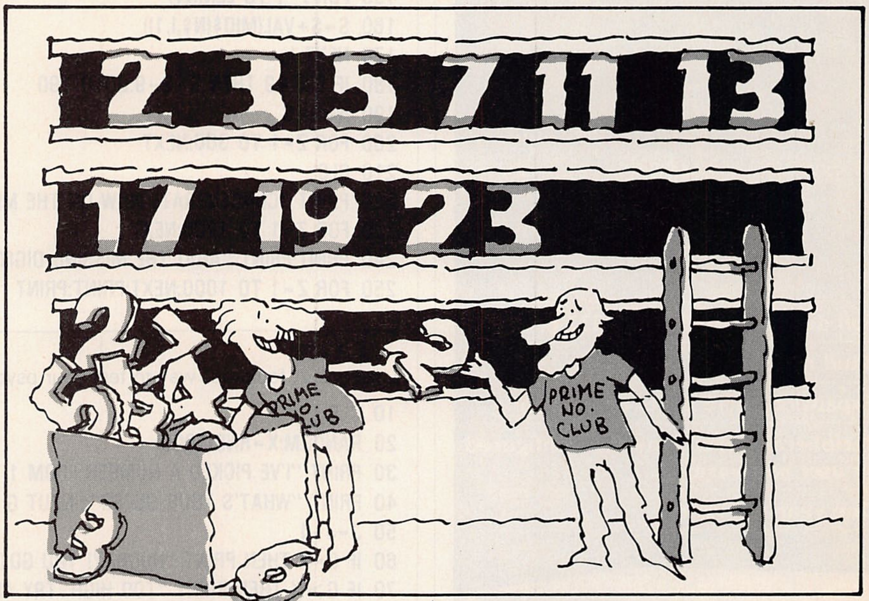

Illustration by Wilbur Bullock

Last month we showed you how to teach your computer some digital magic tricks that involve the phenomenon of cyclic numbers. Before we get to an explanation of last month's "mind reading" program, however, here's a brief description of another program (shown in listing 1) that appears to have psychic powers.

Think of a number, any whole number at all. Pick one that's in the thousands, say, or copy the serial number from one of your dollar bills, and write it down. Now scramble the digits. For instance, if your original number is 4969, the scrambled number might be 6994. Just remember to use the same digits as in the original number and as often as in the original. Then subtract the smaller number from the larger number. You may want to use the immediate command mode of a computer, as in PRINT 6994 – 4969, which will then calculate the difference.

In this example, we get a difference of 2025. Now pick any non-0 digit from the difference. Suppose you pick 5 (remember not to pick 0). The program will ask you to type in the remaining digits, in this case 202. Amazingly, the computer will tell you that the number you picked was 5.

For variation, rather than scrambling the digits you may instead add up the digits of the original number and then do everything else the same (subtract, pick a non-0 digit, and so on). Again, the computer will provide the correct answer (assuming that you haven't made an error somewhere) as to which digit you chose.

Test Your Psychic Powers

Here is a short program (see listing 2) that tests your "psychic powers." The computer will randomly (actually pseudorandomly) generate a whole number from 1 to 1000. When you try to guess the number, the computer will tell you whether your guess is too high or too low and will keep a count of the number of guesses. Rate yourself as follows:

Guesses	Rating
1–2	Suitable for *National Enquirer*
3–4	Very impressive or very lucky
5–6	Quite intuitive—very good
7–9	True mathematician
10–13	Fairly rational or methodical
14–19	Not particularly logical
Over 19	What do these silly tests prove anyway?

Now here's a programming challenge for you. Write a BASIC pro-

---

Contributing editor Dr. Michael W. Ecker is Assistant Professor of Mathematics at Worthington Scranton Campus, Pennsylvania State University.

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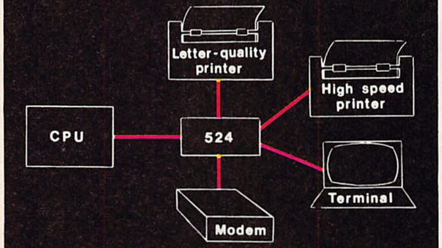

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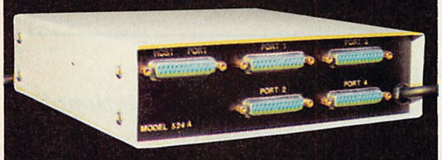

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Listing 1: A BASIC program that guesses your secret number.

```
10 CLS:REM CLEARS THE SCREEN ON TRS-80
20 PRINT:PRINT “THINK OF ANY WHOLE NUMBER.”:PRINT
30 FOR Z=1 TO 1000:NEXT:REM TIME STALLER
40 PRINT “NOW THINK OF ONE WITH THE SAME DIGITS IN A DIFFERENT ORDER.”
50 PRINT:FOR Z=1 TO 2000:NEXT
60 PRINT “NOW SUBTRACT THE SMALLER NUMBER FROM THE LARGER ONE.”
70 PRINT:PRINT:PRINT
80 PRINT “PRESS <ENTER> TO CONTINUE”:INPUT X$
90 CLS
100 PRINT “THINK OF ANY DIGIT IN THE LAST ANSWER (BUT NOT 0).”
110 FOR Z=1 TO 800:NEXT
120 PRINT
130 INPUT “WHAT IS THE NUMBER LEFT IF YOU DELETE THAT DIGIT”;N$
140 S=0
150 FOR I=1 TO LEN(N$)
160 S=S+VAL(MID$(N$,I,1))
170 NEXT I
180 IF S>=9 THEN S=S-9:GOTO 190
190 A=9-S
200 FOR Z=1 TO 300:NEXT
210 CLS
220 PRINT “CONCENTRATE NOW ON THE MISSING DIGIT . . . ”
230 FOR Z=1 TO 1200:NEXT
240 PRINT:PRINT “AHA! THE MISSING DIGIT IS”;A;“!”
250 FOR Z=1 TO 1000:NEXT:PRINT:PRINT
```

Listing 2: A foolproof way to test your psychic powers.

```
10 CLS
20 RANDOM:X=RND(1000)
30 PRINT “I'VE PICKED A NUMBER FROM 1 TO 1000.”
40 PRINT “WHAT'S YOUR GUESS”;:INPUT G
50 J=J+1
60 IF G=X THEN PRINT “HOORAY! YOU GOT IT (IN”;J;“GUESSES).”:END
70 IF G>X THEN PRINT “TOO HIGH. TRY AGAIN.”:PRINT:GOTO 40
80 IF G<X THEN PRINT “TOO LOW. TRY AGAIN.”:PRINT:GOTO 40
```

gram that enables the computer to guess *your* number from 1 to 1000. Send me the program, and I'll pick some for publication several months down the road. You should write the program in a generic Microsoft BASIC so it can be used on as many different kinds of machines as possible. Try to use an algorithm that is efficient, by which I mean some method that enables the machine to guess correctly with as few incorrect guesses as possible. (Incidentally, I'm thinking of the same method used on certain calculators by Texas Instruments, Hewlett-Packard, and others.)

For Your Information

Speaking of algorithms, the word “logarithm” is an anagram—or scrambled version—of “algorithm.” But we've had enough scrambling with the first trick anyway. For the benefit of those of you who have forgotten or never learned what a logarithm (or log) is, it is really just an exponent or power. The definition is as follows: $\log_b(n) = p$ means the same as $b^p = n$. (Read: “The base-b logarithm of n . . . .” The subscript b is the base.) For example, $\log_{10}(1000) = 3$ because $10^3 = 1000$ ($b = 10$, $n = 1000$, $p = 3$).

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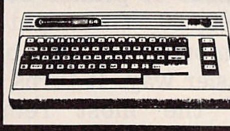

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computed only in a special base called e, a number reportedly named after the great mathematician Euler and having a value of about 2.71828. Strange choice, no? Perhaps, but it turns out that you can still find the more familiar base-10 logs with your computer by using a simple formula that I'll provide in a moment.

First, though, I'd like to point out that we've already encountered the number e in the two preceding months when we compared compound interest rates. We figured out how much money an account would hold after one year if you placed $1 in the account at the beginning of the year and received 100 percent nominal interest under different compounding schedules. As the number of compounding periods increased, you would make more and more money, but after a while you'd reach a limit to how much you could make by increasing the number of periods. Well, that theoretical limit is e, so you would end up with about $2.71 or $2.72 if you could have your interest compounded virtually every instant.

Despite this interesting aspect of the number e and its relation to financial as well as other forms of growth, most of us still feel more comfortable with a base of 10 rather than a base of e. How do you get your computer to give you base-10 logs instead of logs in the base of this strange number e? Simply use the following change-of-base formula: $\log_{10}(x) = \log_e(x)/\log_e(10)$.

Calculating Prime Numbers

Lest you think that base e is such a poor choice, let me mention just one more exotic use of this constant. Recall that a prime number is a whole number whose only integral divisors are 1 and itself. The important part of that sentence is the word "only." The number 5 is prime because 1 and 5 are its only divisors, whereas 6 is not prime because other than 1 and 6, it also has divisors 2 and 3. The first few primes are 2, 3, 5, 7, 11, 13, 17, 19, and 23. Incidentally, for technical reasons, mathematicians do not classify 1 as either prime or nonprime.

Suppose you wanted to estimate the number of primes between 1 and 1,000,000. You might rush to your computer for help, but there is an easier way. It turns out that one of the most remarkable achievements of number theory gives us a means of estimating the number of primes. The rule says, roughly, that the number of primes less than or equal to a number x is approximately equal to $x/\log_e(x)$, that is, x divided by the base-e logarithm of x. Of course, you must remember to round off the answer to a whole number so that it makes sense.

Applying this formula to the question above and letting $x = 1{,}000{,}000$ gives us an answer of approximately 72,382 primes, although we cannot assume that the answer is correct to within more than about 100, given the large size of x. What is an estimate for the number of primes between 1 and 1000? The formula gives an answer of about 145 primes. Using a computer program I wrote to generate primes, I came up with an exact count of 168 primes.

The topic of prime numbers leaves plenty of room for computer exploration, such as writing programs to generate primes, count primes, or compare the count with the estimate provided by the formula. In the latter case, you'd want to find the ratio of the actual number of primes from 1 to x compared to the estimated number of primes from 1 to x. The ratio should approach 1 for larger values of x. I leave you also to consider the question of how to use the formula cited above to estimate the number of primes between, say, 100,000 and 200,000.

Last Month's Trick Explained

In the last issue I presented a trick in which you enter 999999 into a calculator, roll a die or otherwise pick a number from 1 to 6, multiply 999999 by this number, and then divide by 7. I then told you the answer had to include the digits 1, 2, 4, 5, 7, and 8.

Perhaps you've already tried several or all of the possible numbers and realized that the answer always comes out this way. Why? Well, when you multiply 999999 by a number from 1 to 6 and then divide by 7, what you are doing is really the same as dividing 999999 by 7 first, to obtain 142857, and then multiplying by either 1, 2, 3, 4, 5, or 6. The number 142857 happens to have the property that when it's multiplied by any number from 1 to 6, the result always has the same digits. For instance, 6 times 142857 is 857142.

It might further interest you to note that in the division of 1 by 7, we have:

$$1/7 = .142857142857142857\ldots$$

In other words, the block 142857 repeats ad infinitum. This result is not just coincidental, but its explanation is a bit beyond the scope of this column. Mathematically inclined readers may pursue this topic further in my article "The Alluring Lore of Cyclic Numbers" (or in any of the references I provide there) published in the March 1983 issue of the *Two-Year College Mathematics Journal*, published by the Mathematical Association of America and available at many university libraries.

In an upcoming issue we will delve a bit more into the phenomenon of cyclic numbers. □

Editor's Note: The author requests that you send your comments, questions, answers, sugggestions, and programs to:

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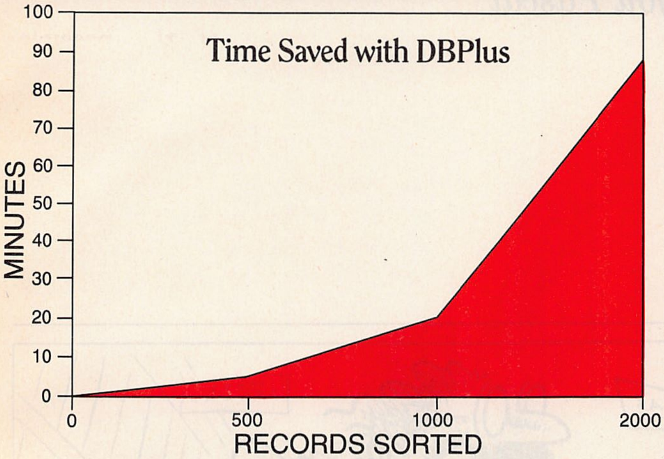

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Programming with Pascal

A sampling of books that try to teach you Pascal

Simple Pascal

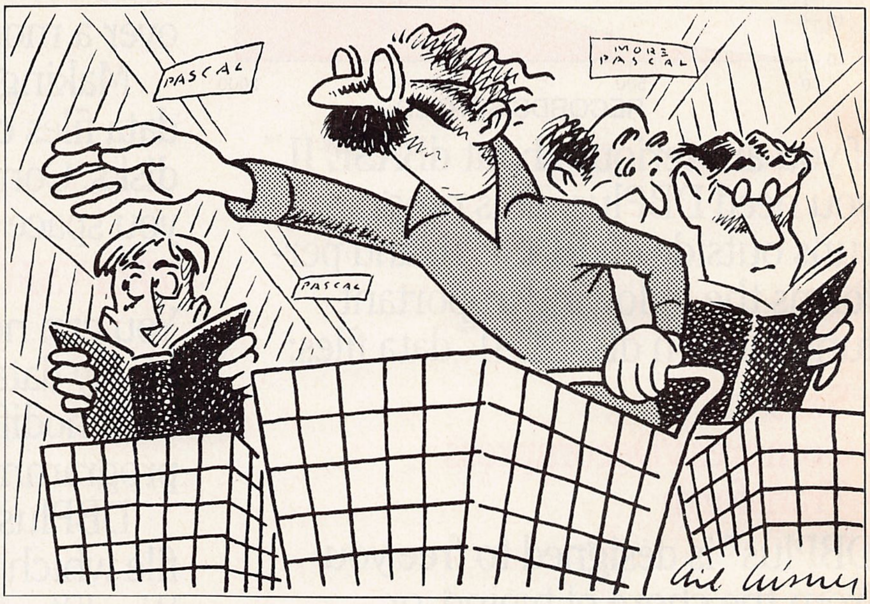
James J. McGregor and
Alan H. Watt
Computer Science Press
Rockville, MD, 1982
182 pages, softcover $12.95

Structured Problem Solving with Pascal

Lawrence Mazlack
Holt, Rinehart and Winston
New York, 1983
386 pages, softcover $21.95

Pascal Primer

David Fox and Mitchell Waite
Howard W. Sams and Company Inc.
Indianapolis, IN, 1981
206 pages, softcover $16.95
Reviewed by Jonathan Amsterdam



If you've recently browsed through computer stores or bookstores, you may have noticed an awful lot of books that try to teach Pascal. There are thick ones and thin ones; some that will teach you everything about Pascal and others that will give you only a taste; some that assume you already know BASIC and others that don't expect you to have ever touched a computer. Here I'll take a look at three representatives of this new fast-growing genre.

Simple Pascal, by James J. McGregor and Alan H. Watt, is anything but simple, and it would be quite a challenge to learn Pascal from this book. Evidence for this claim is the first program in the book, which occurs exactly two sentences into the introduction. If an author is going to present a program that early in a book, it should be as simple as possible, like:

```
program intro(output);
begin
  write('hi there!')
end.
```

which simply writes "hi there!" on the screen. The program at the beginning of *Simple Pascal* is:

```
program room(output);
begin
  writeln('your room needs', 3*2,
    'sq.m. of vinyl');
  writeln('and', 2*(3+2)*3,
    'sq.m. of wallcovering.')
```

Even after you learn that an asterisk means multiplication and that the program is supposed to calculate the floor area and wall area of a 3- by 2- by 3-meter room, you might still have to think a bit about those formulas, especially the second one: why 2*(3+2)*3? It may take you a minute to see that this is the right expression for the wall area of the room—but my point is, why should you have to think about it at all? Maybe I'm being overly picky, but this program is too complicated for the first program some people will ever see.

In fact, the whole beginning of

Jonathan Amsterdam works in the Artificial Intelligence Lab at the Massachusetts Institute of Technology.

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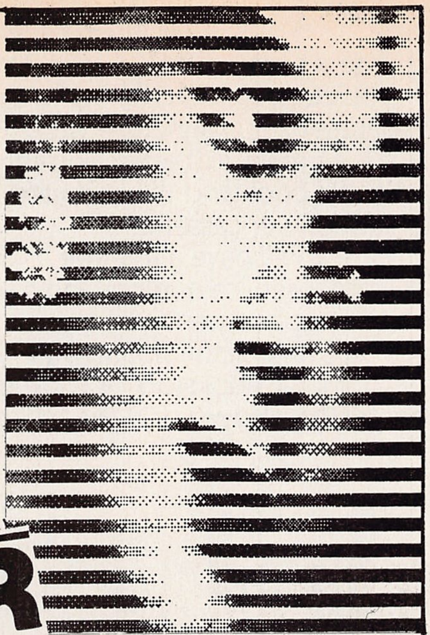

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the book, up to about page 70, is taken up almost entirely with more or less mathematical examples: calculating interest rates, finding the area of a circle, printing an electricity bill, and so on. If calculation is your main interest and doesn't intimidate you, you'll be fine. But if you're interested in word processing or some other aspect of computing, you'll have to wade through the calculations first.

That's just the beginning of the problems with *Simple Pascal.* The writing is dry but readable. Sometimes the authors are a little unclear. For example, here's a sentence about the names of variables: "Names can be of any length but you may find your particular computer system specifies a maximum length." I think the authors mean that some computer systems specify a maximum length and some don't; anyway, the thought certainly isn't well put.

Not only does the writing style leave something to be desired, but the programming style falls short as well. Good programming style means writing readable, easily maintainable programs. For example, suppose you're writing a program that manipulates data for a company with eight employees. Instead of putting the number eight directly into the statements of the program, you could set up what Pascal calls a *constant,* give it a name like numemployees, and use that name throughout the program. That way, when the company grows, you simply change eight to nine in one place in the program. The authors mention this technique but don't apply it to their own programs as often as they could.

Another problem with the book is its poor organization. The book often explains concepts briefly and inadequately at one point and then elaborates later on. It mentions the Pascal set data type at two different places with little explanation of what it is. There's also plenty of Pascal that *Simple Pascal* leaves out; records, user-

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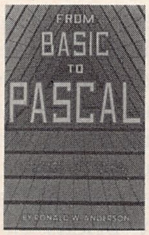
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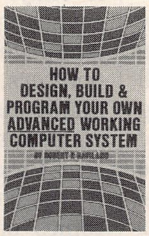
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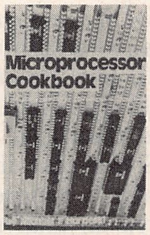
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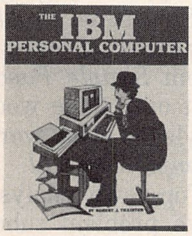
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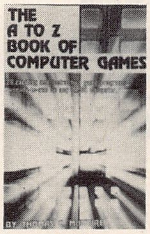
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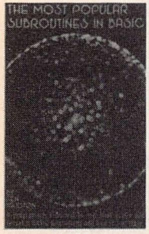
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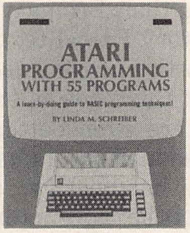
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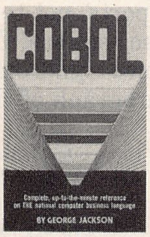

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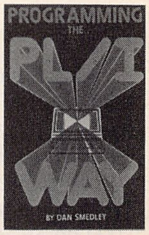
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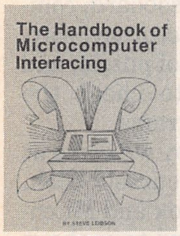
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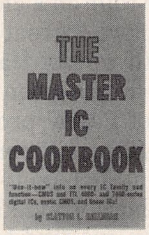
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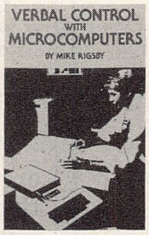
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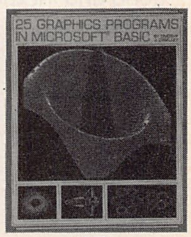
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defined types, recursion and pointers are completely avoided.

The only redeeming feature of the book is the exercises at the end of each chapter, most of which are well designed and interesting. I imagine *Simple Pascal* could be used as a textbook for an introductory course in Pascal if the teacher were good enough. But for self-study, it's rough going.

Structured Problem Solving with Pascal is in most ways a step up from *Simple Pascal,* but it's still not out of the woods. The writing style is even worse than that of *Simple Pascal.* Sentences like "Top-down analysis is a progressive problem subdivision analysis technique" belong in government reports, not textbooks. The author also suffers from the short-sentence syndrome. Here's the first paragraph of the book:

> *Computers are a part of today's world. Almost every day, they affect us by what they do. They can do some things very well and are inadequate for other tasks. The things that they can do well are often things that are simple for people to do. The computer's strength is that it can do simple things faster, cheaper, and sometimes more reliably than people can.*

Mazlack's book is also poorly organized but in a different way than *Simple Pascal* is. Instead of introducing ideas before explaining them, Mazlack does the opposite: He presents everything you need to understand a program before presenting the program itself. Sounds good, right? Unfortunately, it doesn't always work. For example, here's a Pascal statement:

```
if voters < 1 then
  write ('Nobody voted!');
```

Now, I'd guess that most people might have some idea of what this means without knowing that "voters < 1" is a Boolean expression. A well-organized Pascal text would provide the above statement, describe its intuitive meaning (if less than one person voted, write out this fact), and then explain the technical point that "voters < 1" is a Boolean expression that equates with one of the Boolean values true or false. Mazlack reverses this order, presenting the technical stuff first and leaving the reader wondering where and how such things are used.

Aside from these flaws, *Structured Problem Solving with Pascal* is okay. The book is complete—it covers every aspect of the Pascal language, including recursion, files, pointers, and even functional arguments, an obscure topic I don't recall seeing in any other introductory Pascal textbook. Unfortunately, the book presents many of these topics only briefly near the end, but at least it includes them, which is more than I can say for most introductory Pascal texts.

As with *Simple Pascal,* the best part of this book is the exercises. These are even better than those included in *Simple Pascal*—they're clever, imaginative, and helpful. Some of the more interesting exercises deal with topics like finding a knight's tour on a chessboard, computing pi with great accuracy, solving the towers-of-Hanoi puzzle, and writing a program to check the syntax of Pascal programs.

With *Pascal Primer,* we come at last to a real do-it-yourself book. The authors, David Fox and Mitchell Waite, worked hard to make it as readable and entertaining as possible. They've succeeded—this book is actually fun and includes interesting digressions on such topics as the life of Blaise Pascal, and the advantages of Pascal compared to BASIC. The two other books we've looked at paid some attention to programming style, but Fox and Waite are far more persuasive. BASIC programmers who don't see what all the Pascal fuss is about would do well to read the first few pages of *Pascal Primer.* What's even more interesting is the appendix on "Pascal's Bummers"—it's rare to find a textbook that tells you the bad things about what it's trying to teach!

The book is also filled with cartoons that illustrate important points. One cartoon shows the villain of the book, the Sheriff of Buggingham, telling a programmer, "Only one week left! Hurry! Don't worry about using comments! You know what you mean!" The next panel shows the programmer one year later, wondering "Oh no! What did I mean here?" while the sheriff grins wickedly and twists his mustache. You'll also come across numerous quips by "Uncle Pascal," who says things like: "Use fully descriptive variable names. . . . He who calls a bee a butterfly is sure to get stung!" As you can see, reading *Pascal Primer* is entertaining.

The book does have its problems, though. As with many Pascal books coming out nowadays, it concerns itself almost entirely with UCSD Pascal, a dialect of the language developed by Kenneth Bowles at the University of California at San Diego. It's not such a bad idea to base a book on what is currently the most popular dialect of Pascal around; after all, 90 percent of the language is the same no matter what dialect you use. But Fox and Waite overdo it and put too much emphasis on strings and long integers, two features of UCSD Pascal that standard Pascal doesn't have. While the authors confine the programs that use long integers to one chapter, they scatter programs that use strings throughout the book. This practice makes it difficult to use the programs if your version of Pascal doesn't have strings.

The authors concentrate not only on UCSD Pascal but on the version of UCSD Pascal developed specifically for the Apple computer. So besides having to deal with strings, you also have to face, for example, the GOTOXY procedure, which moves the cursor to a specific spot on the screen. Your version of Pascal may call this procedure something different or may not have it at all.

Needless to say, Apple owners have nothing to worry about—they'll be able to type in the sample programs with no changes and have them run perfectly. Everyone else will have some trouble. The authors mention briefly that features such as strings are not included in some versions of Pascal, but they provide no alternative. (By the way, the other two books we've discussed use standard Pascal features.)

Another flaw of *Pascal Primer* is that it doesn't cover all aspects of Pascal. Unfortunately, the authors leave out some important standard features (like record types, for example) to make room for UCSD-specific features like strings and long integers.

One last problem: the book includes no programming exercises. Each chapter ends with a brief quiz on the material, but the authors provide no way to test your programming ability. You'll have to think up programming ideas yourself or perhaps pick up a copy of Mazlack's book.

If you don't use UCSD Pascal, you might find *Pascal Primer* a good introduction to the language, but you'll have to take a lot of what's said with a grain of salt. If you do use UCSD Pascal, this book is definitely worthwhile. And if you also happen to own an Apple, you'll get additional bonuses, like the 8-page appendix on interfacing your Pascal programs with Apple assembly language—something I've never seen mentioned outside of the Apple Pascal manual.

If you own an Apple and you're a complete beginner, *Pascal Primer* is a good choice. I recommend *Structured Problem Solving with Pascal* only if you've already had some programming experience; it's a great source of exercises for sharpening your programming skills. I'm afraid I can't recommend *Simple Pascal.* In fact, if you don't use UCSD Pascal and you're a complete beginner, none of these books is right for you. My advice is to keep browsing at those bookstores. □

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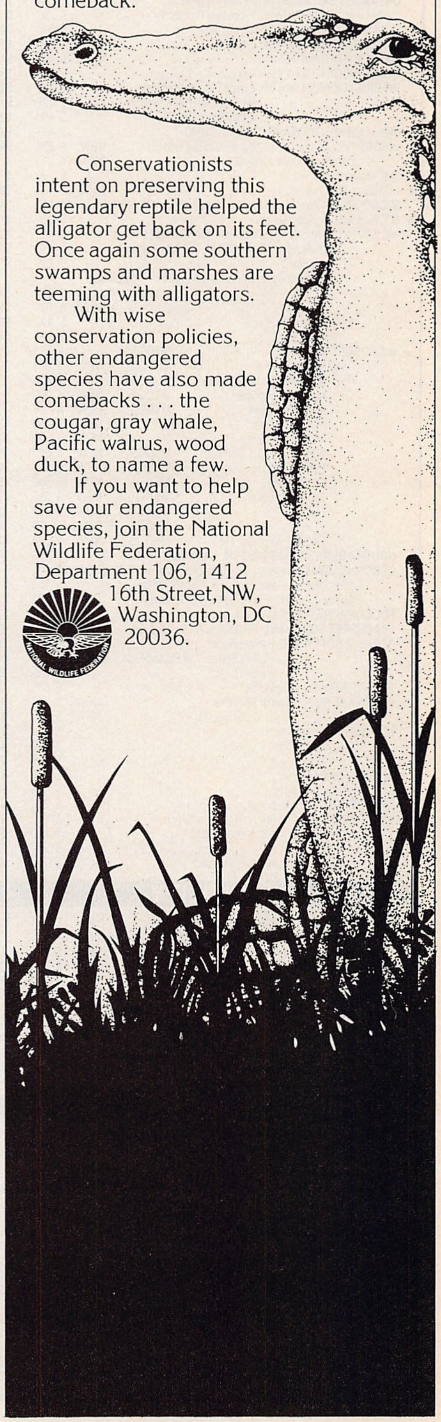

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PFS: Report	NEW!	$ 125	$ 85
SORCIM ISA SuperCalc II		$ 295	$199
SuperWriter		$ 395	$269
Spellguard		$ 195	$129
STC The Creator		$ 300	$195
SYNAPSE File Manager		$ 150	$ 99
SYNERGISTIC Data Reporter		$ 250	$169
★ **VISICORP** VisiCalc™ 256K		$ 250	$179
VisiDex or VisiSchedule, each		$ 250	$199
VisiTrend Plot		$ 300	$219
VisiFile or Desktop Plan I, each		$ 300	$239

UTILITY

		LIST PRICE	OUR PRICE
★ **CENTRAL POINT** Copy II PC Backup and Utility	NEW!	$ 40	$ 35
★ **COMX** Fastrak™, RAM Disk emulator and printer spooler program. Works on any PC DOS version or RAM Card. Menu Driven.	NEW!	$ 100	$ 59
DIGITAL RESEARCH Concurrent CP M-86™		$ 350	$235
CBASIC 86™		$ 200	$135
CP M86		$ 60	$ 40
HAYES Smartcom II		$ 119	$ 89
MICROCOM Microteminal		$ 100	$ 65
MICROSTUF Crosstalk		$ 195	$129
NAGY SYSTEMS Copy PC, Back and Utilities		$ 35	$ 25
NORELL DATA System Back		$ 50	$ 39
NORTON Norton Utilities 14 powerful programs, 3 disks		$ 80	$ 65

HOME & EDUCATIONAL

		LIST PRICE	OUR PRICE
EPYX Automated Simulations Temple of Apshai		$ 40	$ 29
Oil Barons	NEW!	$ 100	$ 75
ARMONK Executive Suite		$ 40	$ 27
BPI SYSTEMS Personal Accounting		$ 195	$139
BRODERBUND Apple Panic		$ 30	$ 22
CONTINENTAL the Home Accountant Plus		$ 150	$112
★ **DATAMOST** Pig Pen or Space Strike, each		$ 30	$ 22
DAVIDSON The Speed Reader II		$ 75	$ 55
INFOCOM Deadline		$ 50	$ 39
Zork I or Zork II or Zork III, each		$ 40	$ 29
★ **INSOFT** Word Trix or Quotrix or Mystrix, each	NEW!	$ 35	$ 29
MICROSOFT Flight Simulator (by Sub-Logic)	NEW!	$ 50	$ 35
SIERRA ON-LINE Ulysses & The Golden Fleece		$ 35	$ 25
PBL CORP. Personal Investor		$ 145	$ 99
SIRIUS Conquest, or Call to Arms, each		$ 30	$ 23
SIR-TECH Wizardry, Scenerio #1		$ 60	$ 40
SPINNAKER Snooper Troops #1 or #2, each		$ 45	$ 35
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STRATEGIC the Warp Factor		$ 40	$ 30

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MEMORY CHIP KITS 64K Kit, 200NS, 9 chips, 4164		$ 150	$ 49
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AST Combo Plus, 64K w async para & clock cal		$ 395	$ 279
Above Combo Plus, 128K, S P C		$ 495	$ 375
Above Combo Plus, 256K, S P C		$ 695	$ 525
★ **ComX** 256K RAM Card w Fastrak™ RAM disk emulator and printer spooler software. 2 Year Warranty		$ 750	$ 225
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9 Foot Cable for IBM Keyboard (extends 3' to 9')		$ 50	$ 35
Key Tronic KB5150, Standard Typewriter key locations	NEW!	$ 269	$ 179
MICROSOFT 64K RAM Card w Parity		$ 350	$ 250
256K RAM Card w Parity		$ 875	$ 625
64K System Card, 4 Function		$ 395	$ 295
256K System Card, 4 Function		$ 625	$ 465
MBI Monte Carlo 64K Five Function (to 1000K)		$ 625	$ 395
Q.C.S. Big Blue, Z80 CPU plus five functions		$ 595	$ 449
QUADRAM CORPORATION			
★ Quadlink, IBM to Apple II Link		$ 680	$ 580
Quadboard 64K, expandable to 256K, 4 function board		$ 395	$ 285
★ Quadboard 256K, four function board		$ 595	$ 425
Quad 512 +, 64K plus serial port		$ 325	$ 275
Quad 512 +, 256K plus serial port		$ 550	$ 440
Quad 512 +, 512K plus serial port		$ 895	$ 675
Quadcolor I		$ 295	$ 235
Microfazer, w Copy, Par Par, 8K, #MP8 w Power Supply		$ 189	$ 139
Microfazer, w Copy, Par Par, 64K, #MP64 w Power Supply		$ 319	$ 235
Microfazer, w Copy, Par Par, 128K, #MP128 w Power Supply		$ 465	$ 345
Microfazer, Snap-on, 8K, Par Par, Epson, #ME8, w Power Supply		$ 179	$ 145
Microfazer, Snap-on, 64K, Par Par, Epson, #ME64, w Pwr. Supply		$ 319	$ 235
All Microfazers are expandable (w copy to 512K) (Snap-on to 64K)			
TG PRODUCTS Joystick		$ 65	$ 49

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DISK DRIVES Double Sided 360K 320K. Same as now supplied with IBM-PC & XT. Tested, burned-in. With installation instructions. 90 day warranty by us.	1 each	$ 529	$ 239
	2 or more	$ 529	$ 239
Half Height 360K or 320K Drives, same as above		$ 395	$ 199
DAVONG LIMITED SPECIAL INTERNAL Hard Disk, (For PC-1, includes Power Supply & Controller	5-6MB	$1995	$1195
	10-12MB	$2395	$1495
	15-19MB	$2795	$1895
MAYNARD Floppy Drive Control Board, for up to 4 drives.		$ 195	$ 165
same with Serial Port		$ 325	$ 235
same with Parallel Port		$ 275	$ 205

PRINTERS AND ACCESSORIES

EPSON MX or FX PRINTERS		CALL	CALL
LEADING EDGE, Gorilla Banana	NEW!	$ 250	$ 209
PRACTICAL PERIPHERALS, Microbuffer In-Line 64K Parallel Universal Buffer		$ 349	$ 259
Microbuffer In-Line 64K Serial Universal Buffer		$ 349	$ 259
★ **STAR MICRONICS**, 9x9 Dot Matrix, 100cps, 2.3K, Gemini 10"		$ 499	$ 349
9x9 Dot Matrix, 100cps, 2.3K, Gemini 15"		$ 649	$ 469
IBM-PC to Epson or Star Micronics Cable		$ 60	$ 35
Apple Interface and Cable for Epson or Gemini		$ 95	$ 59
Grappler + by Orange Micro, specify printer		$ 165	$ 119
Apple Graphics Dump Program by Epson		$ 15	$ 9
LETTER QUALITY – DAISY WHEEL PRINTERS			
COMREX, Comriter CR-1, I/F, 200 wpm	Limited Special	$1199	$ 645
Comriter Tractor Feed for CR-1		$ 118	$ 99
SMITH-CORONA, TPI Printer specify serial or parallel I/F	Special	$ 899	$ 499
TPI Tractor Feed		$ 149	$ 129

SUPPLIES: Tractor Feed Paper, Ribbons, Heads, Qume Daisy Wheels and Ribbons.

8" CP/M-80 BUSINESS & SYSTEM SOFTWARE - PARTIAL LIST, CALL

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INFOCOM, Zork I or Zork II or Zork III or Starcross, each		$ 50	$ 39
MICROCRAFT, Verdict (Legal) or Billkeeper (Professional), each		$ 995	$ 469
MICROPRO, WordStar® plus free WordStar Training Manual		$ 495	$ 269
MailMerge™ (Call on 2 Pak, 3 Pak and others)		$ 250	$ 129
SpellStar™		$ 250	$ 129
WordStar Professional, 4 Pak, 3 above + StarIndex		$ 895	$ 429
InfoStar	NEW!	$ 495	$ 269
ReportStar	NEW!	$ 350	$ 199
MICROSOFT Multiplan		$ 275	$ 199
Fortran 80		$ 500	$ 325
BASIC Compiler		$ 395	$ 295
COBOL-80		$ 750	$ 545
BASIC-80 Interpreter		$ 350	$ 275
muLisp/muStar-80		$ 200	$ 145
M-Sort-80		$ 195	$ 145
Edit-80		$ 120	$ 80
Macro-80		$ 200	$ 145

MONITORS AND ACCESSORIES

AMDEK, 12" Green, #300G	$ 200	$ 159
12" Amber, #300A	$ 210	$ 159
★ 13" Color I, Composite	$ 379	$ 299
★ 13" Color II, RGB, Hi Res (Ap. II, III & IBM-PC)	$ 529	$ 459
★ 13" Color III, RGB, Commercial. (Ap. II, III)	$ 479	$ 399
DVM, Color II or III to Apple II Interface	$ 199	$ 175
NEC, 12" Green, Model JB1201M	$ 249	$ 159
12" Color, Composite, Model JC1212M	$ 450	$ 349
PRINCETON, RGB Hi Res	$ 795	$ 539
QUADRAM, Quadchrome 12" RGB Color	$ 795	$ 565
SANYO, 9" Green, Model DM5109	$ 200	$ 139
12" Green, Model DM8112CX	$ 260	$ 199
13" Color, Composite, Model DM6013	$ 470	$ 349
TAXAN, RGB Vision I 380 Lines	$ 399	$ 339
ZENITH, 12" Green, Model ZVM121	$ 150	$ 99

MODEMS AND ACCESSORIES

AXLON, Datalink 1000 Hand Held Communications Terminal	$ 399	$ 299
HAYES, Micromodem II (for the Apple II)	$ 379	$ 275
Apple Terminal Program for Micromodem II	$ 100	$ 65
IBM-PC Smartcom II	$ 119	$ 89
Stock Chronograph (RS-232)	$ 249	$ 189
Smartmodem 300 (RS-232)	$ 289	$ 225
Smartmodem 1200 (RS-232)	$ 699	$ 535
Micromodem 100 (S-100 bus)	$ 399	$ 275
IBM-PC to Modem Cable	$ 39	$ 29
MICROCOM, Micro Courier for Apple II	$ 250	$ 125
Micro Telegram for Apple II	$ 250	$ 125
NOVATION, Applecat II Modem, 300 BAUD	$ 389	$ 269
212 Apple Cat, 1200 BAUD	$ 725	$ 599
SIGNALMAN, Modem MKI (RS-232)	$ 99	$ 79
SSM, Transcend 1 for Apple II Data Comm.	$ 89	$ 69
ModemCard for the Apple II	$ 299	$ 259

CORVUS

6 Meg Hard Disk, w/o Interface	$2395	$1895
11 Meg Hard Disk, w/o Interface	$3195	$2695
20 Meg Hard Disk, w/o Interface	$4195	$3495
IBM-PC Interface (IBM DOS), Manual & Cable Kit	$ 300	$ 239
Mirror built in for easy backup	$ 790	$ 595
Apple Interface, Manual & Cable Kit	$ 300	$ 239

Other Interfaces, Omni-Net, Constellation, Mirror, All in Stock

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H/P 41C Calculator	$ 195	$ 149
H/P 41CV Calculator with 2.2K Memory	$ 275	$ 219
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DYSAN, 10 each, 5-1/4, SS, SD, (Apple, etc.)	$ 69	$ 39
10 each, 5-1/4, DS, DD, 48T (IBM, H/P, etc.)	$ 89	$ 49
MAXELL, 10 each, 5-1/4, MD-1, SS, SD or SS, DD	$ 55	$ 35
GENERIK™ DISKETTES		
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★ 1000 each DS, DD, 40 Track (IBM, H/P, etc.)	$4550	$1200

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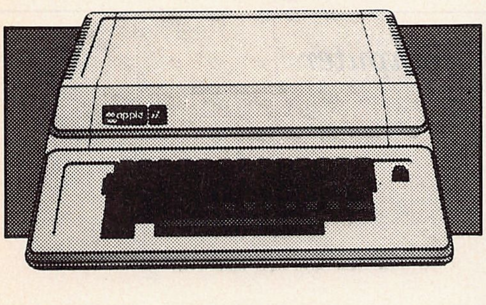

APPLE IIe 64K, 40 COLUMN	$1,175
APPLE IIe 128K, 80 COLUMN	$1,395
APPLE IIe, STARTER SYSTEM BY APPLE (System A) 64K and 80 column Disk II with controller Apple Monitor III Monitor Stand	$1,695
APPLE IIe STARTER SYSTEM BY COMPUTER EXCHANGE [SYSTEM B] 128K and 80 column 1 Micro-Sci Drive with controller Filer, Utility and DOS 3.3 Diskette Sanyo 9" Green Monitor RF Modulator (for color TV) Game Paddles Game with color graphics and sound	$1,875

WARRANTY is 100% Parts and Labor for 90 days by us.

To substitute or delete drive on System B, subtract $245 and add drive price (System D)

To add on Micro-Sci A2 Drive to above, add $245. (System DD)

To substitute or delete monitor on System B, subtract $130 and add other monitor price (System M).

DISK DRIVES for APPLE II+/IIe

μ-SCI MICRO-SCI	A2, 5-1/4", 143K Disk Drive	$ 479	$ 249
	Controller Card for A2 Drive	$ 100	$ 79
	★A40, 5-1/4", 160K Disk Drive	$ 449	$ 299
	★A70, 5-1/4", 286K Disk Drive	$ 599	$ 299
	Controller for A40 or A70	$ 100	$ 79
	Filer, Disk Utility Software	$ 20	$ 15
VISTA	Solo, 5" 143K Disk Drive Std. Height	$ 300	$ 249
	Duet, 5", Double Sided, 320K Half Height	$ 420	$ 329
	Quartet, 5", 2 Duets Side by Side or Standard Cabinet	$ 715	$ 575
	Controller Card	$ 89	$ 75
	★V1000 Dual 8", Std. Format w/Controller, Complete	$2195	$1295
TEAC	✱143K Disk Drive, 1/2 High	$ 379	$ 279
	Controller Card.	$ 89	$ 69
	✱Electronics by ComX		
★ **CENTRAL POINT**, Filer, Utility and DOS 3.3		$ 20	$ 15

HARDWARE

for Apple II

RAM EXPANSION

	LIST PRICE	OUR PRICE
★ **ComX**, for IIe, 80 col./64K Adder Card	$ 295	$145
★ **ComX**, RAM Card, 2 Yr. Wty. (II+) 16K	$ 179	$ 39
★ **ALS**, ADDRam (II+) 16K	$ 100	$ 69
★ **Microsoft**, RAMCard (II+) 16K	$ 100	$ 79
★ **Saturn Systems**, RAM Card (II+) 32K	$ 249	$169
RAM Card (II+) 64K	$ 425	$319
RAM Card II(+) 128K	$ 599	$459
★ **Axlon RAM Disk System** (+ or e) 320K	$1395	$795

VIDEO CARDS

★ **ALS**, Smarterm II (+ or e)	$ 179	$139
ComX, 80 col./64K Adder (IIe)	$ 295	$145
Videx, Videoterm 80 col. (+ or e)	$ 345	$229
★ UltraTerm (+ or e)	$ 379	$279
Soft Video Switch (II+)	$ 35	$ 25
Enhancer II (II+)	$ 149	$ 99
Function Strip (II+)	$ 79	$ 59
Full Videx Line. Call. Up to 35% off.		
Vista, Vision 80	$ 289	$199

MISCELLANEOUS

ALS, The CP/M Card V3.0 (+ or e)	$ 399	$299
Z-Card (+ or e)	$ 169	$129
Color II (+ or e)	$ 179	$139
ASTAR, RF Modulator	$ 35	$ 25
CCS, Serial Interface 7710A	$ 150	$129
Dan Paymar, Lower Case Chip (II+)	$ 50	$ 39
Don't Ask, DAO 003 S.A. Mouth	$ 125	$ 85
★ **Eastside**, Wild Card, copier	$ 130	$ 99
Kensington, System Saver	$ 90	$ 69
Key Tronic, KB200 keyboard, 84 keys (II+)	$ 298	$198
Kraft, Joystick (Ap II/II+)	$ 65	$ 49
Paddle (Ap II/II+)	$ 50	$ 39
M&R, Sup R fan	$ 50	$ 39
★ **Microsoft**, Z80 Softcard (+ or e)	$ 345	$235
Z80 Softcard Plus (+ or e)	$ 645	$459
Softcard Premium Pack (II+)	$ 695	$495
Softcard Premium Pack (IIe)	$ 495	$395
Micro Tek, Dumpling 64, Buffer	$ 349	$269
★ **Orange Micro**, Grappler Plus	$ 165	$119
Practical Peripherals.		
MBP IIe 64K Par. (Epson Internal) (+/e)	$ 279	$209
MBS IIe 32K Ser. (Epson Internal) (+/e)	$ 219	$169
Microbuffer II+, 16K, (+ or e) Par/Ser (specify)	$ 259	$199
Microbuffer II+, 64K, (+ or e) Par/Ser (specify)	$ 349	$259
PCPI, Appli-Card, 14 features 4 Mhz	$ 295	$235
6 Mhz	$ 375	$275
RH Electronics, Super Fan II	$ 75	$ 59
★ **Saturn Systems**, Accelerator II	$ 599	$449
SSM, A10 II, Serial/Para Interface	$ 225	$169
TG Products, Game Paddles (II+)	$ 40	$ 29
Joystick (II+)	$ 60	$ 45
Select-A-Port (II+)	$ 60	$ 45
Trak Ball (II+)	$ 65	$ 44
Videx, PSIO, Para/Ser Interface	$ 229	$169
WICO, Trackball (Ap II/II+)	$ 90	$ 61
Analog Joystick	$ 70	$ 47

SOFTWARE

on disk for Apple II/II+/IIE

BUSINESS

		LIST PRICE	OUR PRICE
Apple Computer, Inc. 50% off list, on Apple Inc. software			Call
Applied Soft Tech., VersaForm		$ 389	$265
Artsci, MagicWindow II	NEW!	$ 150	$ 99
Ashton-Tate, dBase II (CP/M)		$ 700	$439
Financial Planner		$ 700	$439
User's Guide by Software Banc		$ 30	$ 20
BPI Systems, GL, AR, AP, PR or INV, each		$ 395	$295
Job Cost		$ 595	$435
Broderbund, Bank Street Writer		$ 70	$ 47
Continental, GL, AR, AP or PR ea		$ 250	$169
Home Accountant		$ 75	$ 49
FCM		$ 100	$ 68
Dow Jones, Market Analyzer		$ 300	$239
Hayden, Pie Writer (Specify brd.)		$ 150	$ 99
Howard Soft, Real Estate Analyzer II		$ 195	$129
Tax Preparer		$ 225	$149
Info. Unlim., Easywriter (PRO)		$ 175	$119
LJK, Letter Perfect w/Mail Merge		$ 150	$ 99
★ **Micro Craft**, (requires Z80 CP/M-Card)			
Professional Billkeeper		$ 995	$469
Verdict, (Legal Billing)		$ 995	$469
★ **Micro Lab**, Tax Manager		$ 180	$119
Micro Pro, (all require Z80-CP/M Card)			
WordStar® + Training Manual	SPECIAL	$ 495	$269
MailMerge™	SPECIAL	$ 250	$129
SpellStar™	SPECIAL	$ 250	$129
WordStar Professional, 4 Pak, 3 above + Star Index	SPECIAL	$ 895	$429
WordStar w/Applicard & CP/M (special)		$ 495	$345
Microsoft, Multi-Plan (CP/M or Apple DOS)		$ 275	$199
Financial, Multitool (CP/M or DOS)		$ 100	$ 75
Budget, Multitool (CP/M or DOS)		$ 150	$115
Sierra/On-Line, ScreenWriter II		$ 130	$ 89
The Dictionary	NEW!	$ 100	$ 69
General Manager II	NEW!	$ 230	$155
Osborne/C.P. Soft, (Disk and Book)			
Some Common Basic Programs (75 each)			
Statistics and Math Programs		$ 100	$ 49
Practical Basic Programs (40 each)		$ 100	$ 49
Peachtree, Requires CP/M & MBasic, 40 columns.			
Series 40 GL & AR & AP, all 3		$ 595	$395
Series 40 Inv. or Pay., each		$ 400	$275
Series 9 Text & Spell & Mail, all 3		$ 595	$395
Perfect, Perfect Writer		$ 495	$219
Perfect Speller		$ 295	$129
Perfect Writer/Speller 2 Pak		$ 695	$299
Perfect Filer		$ 595	$259
Quark, Word Juggler (IIe)		$ 239	$179

		LIST PRICE	OUR PRICE
Sensible, Sens. Speller, specify version		$ 125	$ 85
★ **Silcon Valley**, Word Handler		$ 250	$139
Sof./Sys., Executive Secretary		$ 250	$169
Executive Speller		$ 75	$ 55
Software Publishing, PFS: File		$ 125	$ 85
(specify + or e) PFS: Report		$ 125	$ 85
PFS: Graph		$ 125	$ 85
Stoneware, DB Master		$ 229	$155
DB Utility I or II		$ 99	$ 69
DB Master 3 Pak, Special		$ 687	$387
Videx, Applewriter II preboot disk		$ 20	$ 15
Visicalc 80 col. preboot disk		$ 50	$ 39
Visicalc 80 col. to 176K disk		$ 90	$ 69
Videoterm Utilities Disk		$ 37	$ 28
VisiCorp/Personal Software.			
Visicalc 3.3		$ 250	$169
Visicalc Enhanced (IIe)	NEW!	$ 250	$169
VisiFile or VisiDex, each		$ 250	$169

UTILITY & DEVELOPMENT

Beagle, Utility City		$ 30	$ 22
DOS Boss		$ 24	$ 18
Apple Mechanic		$ 30	$ 22
Central Point, Filer, DOS Utility		$ 20	$ 15
★ Copy II Plus (bit copier)		$ 40	$ 35
Computer Appli., Nibbles Away II		$ 70	$ 59
Epson, Graphics Dump		$ 15	$ 9
Insoft, GraFORTH by Paul Lutus		$ 75	$ 59
Microsoft, A.L.D.S.		$ 125	$ 75
BASIC Compiler		$ 395	$299
Cobol 80		$ 750	$559
Fortran 80		$ 195	$149
TASC Compiler		$ 175	$159
★ **Omega**, Locksmith (bit copier)		$ 100	$ 75
Penguin, Comp. Grphcs. Sys.	NEW!	$ 70	$ 53
Graphics Magician	NEW!	$ 60	$ 41
Phoenix, Zoom Grafix		$ 40	$ 34
Quality, Bag of Tricks	NEW!	$ 40	$ 29
Saturn Systems, VC-Expand		$ 100	$ 49
VC-Expand 80		$ 125	$ 69
Sensible, Back it Up, (bit copier)		$ 60	$ 49

HOME & EDUCATION

Broderbund, Choplifter	$ 35	$ 26
BudgeCo, Pinball Constr. Set	$ 40	$ 27
Continental, Home Accountant	$ 75	$ 49
Datamost, Aztec or Zaxxon, each	$ 40	$ 27
Edu-Ware, (Large Inventory)	Call	Call
Hayden, Sargon II (Chess)	$ 35	$ 29
Infocom, Zork I, II, or III, or Starcross, each	$ 40	$ 27
Deadline	$ 50	$ 34
Lightning, Mastertype	$ 40	$ 27
Micro Lab, Miner 2049er	$ 40	$ 27
Muse, Castle Wolfenstein	$ 30	$ 23
Sierra/On-Line, Ultima II	$ 60	$ 40
Softporn (X Rated)	$ 35	$ 22
Sir-Tech, Wizardry	$ 50	$ 39
Sub Logic, Flight Simul.	$ 34	$ 25

OTHER BRANDS AND PROGRAMS IN STOCK. CALL.

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FOR APPLE II/II+/IIe

★ **ALS**, Synergizer + Supercalc + Condor for (II+)	$ 749	$399
Anadex, DP8000, Dot Matrix Printer	$ 995	$395
CCS, Serial Interface 7710A	$ 150	$129
★ **ComX**, 16K RAM Card, 2 Yr. Warranty, for II+	$ 179	$ 39
M&R, SupRterm 80 col. for II+	$ 375	$199
MicroCom, Micro Courier	$ 250	$125
Micro Telegram	$ 250	$125
Micro-Sci, A70, 5 1/4" 286K Disk Drive	$ 599	$299
Microsoft, 16K RAMCard for II+	$ 100	$ 79
Saturn Systems, 32K RAM Card for II+	$ 249	$169
Silicon Valley, Word Handler	$ 250	$139
Videx, Videoterm, 80 column card for II+	$ 345	$229

SYSCOM II

Apple II+ Work-a-like

Note: Substitutions and deletions same as System B apply. Syscom 2 is software and hardware compatible to the Apple II+.

Syscom 2, 64K (Apple II + Compatible)	$ 869	$ 659
Syscom 2, 64K Starter System (same as Apple IIe System B above except 64K, 40 columns)	$1810	$1195

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Rampower 128K System (800)	$ 475	$295
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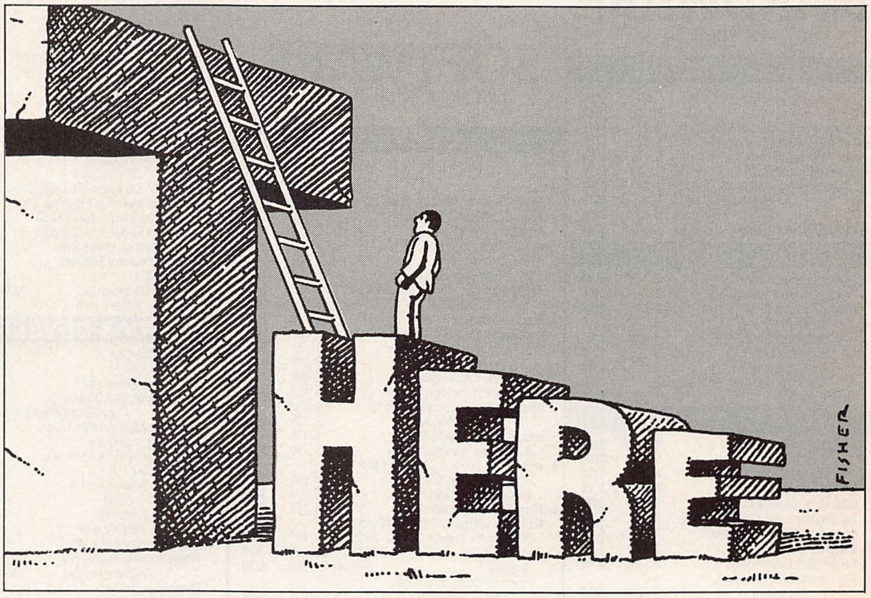
Translating BASIC Programs

How to convert program listings to run on your computer

by George Stewart



This month we'll show you how to convert BASIC programs to match your computer's dialect, so that whenever you see an interesting program listing in a magazine, you can make a good try at running it, even if your computer's version of BASIC is different from the one used in the listing. We can't promise you a rose garden—in fact, we can assure you that you'll have a fair share of frustrations. Nevertheless, if you treat each translation exercise as an adventure game and set plenty of intermediate goals, you'll find the effort enjoyable.

Tools of the Trade

You've found a BASIC program listing you want to run on your computer. What else do you need?

For starters, get the BASIC language reference manual that comes with your computer. The more familiar you are with the manual's contents, the better. If you don't know anything about BASIC programming, your adventure will be rocky at first, but translating program listings is actually a pretty good way to get into programming.

It would also be helpful to have some information about the version of BASIC used in original listing. Most computer manufacturers sell language reference books separately from the computers. Some of the more eccentric versions of BASIC to watch out for include TI BASIC, HP BASIC, and Sinclair BASIC. This isn't necessarily a criticism of these dialects, mind you, just an observation about their divergence from the most widely used form of BASIC, Microsoft BASIC.

Ideally, you should have a complete list of all keywords (also known as reserved words) that are used in your version of BASIC and a list of the keywords used in the original listing. These lists will speed your translation task significantly because you'll be able to compile a cross-reference or translation table by referring to the two lists.

Another valuable tool is *The BASIC Handbook*, by David Lien (Compusoft Publishing Company, San Diego, CA, 1981). This encyclopedic work gives capsule explanations of almost every keyword used in more than 250 versions of BASIC.

The Feasibility Study

Before undertaking the translation, take a hard look at the original program just to make sure you understand the size of the task at hand. Here are some questions to ask.

Does the program generate screen graphics? In

George Stewart is senior technical editor of *Popular Computing*.

Illustration by Mark Fisher

other words, does the program produce line drawings, charts, or patterns on the screen? Graphics techniques and capabilities vary widely from one computer to another, and translating graphics often requires that you totally rewrite the relevant sections of the program. On the other hand, the graphics may be unimportant, in which case you can omit these parts of the program or substitute simplified routines.

Does the program rely on any machine-language subroutines? The keywords USR and CALL are dead giveaways that a program includes machine-language subroutines. These subroutines sometimes give you faster performance than is possible with BASIC or let you use the computer in a way that is not possible with BASIC statements. In any event, if the original program uses machine-language subroutines, don't try to translate it unless you understand the machine or assembly languages used on both the original computer and your own.

Does the program make frequent use of PEEK, POKE, INP, or OUT? These keywords directly address the computer hardware (memory or input/output devices). As such, their function in a program is machine-specific. You may be able to do the same thing on your computer, but you will almost certainly have to make significant changes in the program to get the desired results.

If the program performs any numeric calculations, how much precision is needed? If the program needs only six or seven digits of precision, you'll have no problem. However, for many financial and scientific applications, you'll need closer to 14 digits. Make sure your computer offers sufficient precision to meet the requirements of the application.

How much RAM (random-access memory) does the program require? If your computer has at least 32K bytes of RAM, you probably won't have to worry about storage requirements (most people would not want to translate a program that needs that much memory anyway). However, if your computer has 16K bytes or an even smaller storage capacity, you'll need to make sure your computer can hold the program.

Judging memory requirements is often tricky because a program's length alone may not be an accurate indicator. You have to estimate the number of bytes the program itself will occupy and the number of bytes needed for storing data and temporary results while the program runs.

When ordinary text is stored in a computer, each character generally occupies one byte. From this you might deduce that a BASIC program whose printed listing contains exactly 10 characters would require 10 bytes of memory. Unfortunately, it isn't so simple.

Most BASIC interpreters store programs in a compressed form while they are in memory. A keyword such as PRINT requires only 1 byte of memory rather than the 5 bytes you might anticipate by counting the number of letters in the word. Also, line numbers usually require just 2 bytes regardless of how many digits they consist of. Programs require additional memory while running to store numeric and string data. Arrays in particular tend to require lots of memory. For example, a 100 by 10 array of single-precision numbers might require 4000 bytes.

Gauging a program's length and memory requirements can be an involved process. For a fuller explanation of the technique, see Ask Popular (page 18) in the July 1983 issue of *Popular Computing*. If your computer has a small RAM capacity, you'll probably find that discussion quite useful.

What are the program's mass-storage requirements? Occasionally, you'll come across a program that requires a disk or cassette system for storing data. This requirement makes the translation job more difficult than that of RAM-only programs because file-storage techniques—like those for graphics—vary from one computer to another. Having the requisite disk or cassette is less than half the battle. You also need a thorough understanding of both the file access method used in the program and your computer's file capabilities. Find out if the program uses random access, sequential access, indexed sequential access, or some other technique, and make sure your computer has a corresponding capability.

As you may have guessed by now, the secret to success in translating programs is picking the right sort of listing to start with. Here's a profile of the ideal candidate for translation:

- The screen display is all text—no graphics.
- The program uses no machine-language subroutines.
- The program has no PEEK, POKE, INP, or OUT statements.
- Numeric calculations are limited to simple arithmetic: addition, subtraction, multiplication, division, and possibly exponentiation, with no more than seven digits of precision required.
- Keyboard input is done via simple INPUT statements.
- The program is relatively short—100 or fewer numbered lines.
- Ample documentation is provided with the program, either in accompanying text or incorporated into the program as REM (remark) statements.

The Adventure Begins

After performing the initial feasibility study, you can jump right into the details of translating the program. Start by identifying all the keywords, variable names, and line-number references.

Keywords are the predefined words and symbols that a BASIC interpreter can understand, such as PRINT, INPUT, READ, FOR, NEXT, and even +, −, *, and /. For each keyword in the original program listing, check to see whether your computer's version of BASIC includes that keyword or another one that does the same thing. For example, CLS on TRS-80s is equivalent to HOME on Apples; both clear the screen. If your computer doesn't have a keyword or a substitute, you can usually get the same results by programming your own subroutines (see box on page 236).

Variable names are the labels used to identify numeric and string (character-oriented) data. Conventions for constructing variable names vary, but in most versions of BASIC variable names must begin with a letter and may be followed by a second number or letter (A, AA, and A1 are examples of valid variable names; 1A is invalid). Some versions of BASIC allow longer variable names. If the original program uses longer variable names than your BASIC allows, you must carefully modify each variable reference to suit your own BASIC while preserving the uniqueness of each variable. GROSSPAY and GROSSEARNINGS, for example, cannot both be shortened to GR.

Another convention is to use the $, !, %, and # signs to indicate string, single-precision, integer, and double-precision variables, respectively. Here are examples:

```
100 A$="THIS IS A STRING"
110 N!=100.5
120 K%=10
130 PI#=3.14159265358979
```

If the original program uses a type of variable that your computer can't handle, take another hard look at the feasibility of translating the listing.

Line-number references correspond to the numbered lines in a BASIC program. Each "logical line" in a program begins with a line number; however, a single logical line may require several "physical lines" on your computer's display. Line-number references also appear in conjunction with the keywords GOTO, GOSUB, ON-GOTO, ON-GOSUB, IF-THEN-ELSE, and ON ERROR GOTO.

Line numbers probably won't cause you any problems in translation unless the original program uses multistatement lines and your computer doesn't allow them. In that case, you'll need to do extensive renumbering. For example:

```
100 IF A=1 THEN GOSUB 1000: GOTO 50
110 INPUT "ENTER ANOTHER NUMBER"; A
120 GOTO 50
```

Line 100 contains two distinct statements. If your computer's BASIC lets you use only one statement per line, you might need something like this:

```
100 IF A=1 THEN 115
110 INPUT "ENTER ANOTHER NUMBER"; A
```

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```
112 GOTO 50
115 GOSUB 1000
120 GOTO 50
```

But you have to be sure that your added lines don't conflict with existing lines in the program.

The next step in program translation is to analyze the logical blocks of the program. Of course, the ease of this task depends on how well the program is structured and documented. You should also determine the general purpose of each variable used in the program. Understanding a program's organization and use of variables is a good first goal; it can be quite a challenge if the program is poorly documented. You can try to skip this step and forge ahead with line-by-line translation, but when you come to debugging your handiwork, you'll probably end up doing this analytic work anyway. It's best to do it now.

Specific Problems

By this time, you've probably identified any potential trouble spots in the translation project. We'll look at the most common ones.

Strings. A string is a sequence of characters. Quite often, a program needs to search through a string, use a portion of it (a substring), or replace part of it. The methods for doing these things vary, depending on whether a computer uses dynamic string allocation or preallocation of string space.

Microsoft BASIC uses dynamic string allocation, assigning space to strings as the need arises during program execution. The CLEAR statement sets the maximum amount of space that will be available for strings, but the specific amount allocated to any given string varies according to the requirements of the program. In Microsoft BASIC, the LEFT$, RIGHT$, and MID$ functions give you access to various portions of a string. MID$(A$,5,3) refers to the 3-character substring of A$ starting at position 5, for example.

Some versions of BASIC (HP BASIC, for example) don't use dynamic string allocation. Instead, they require that you preallocate the space for each string in your program by using the DIM statement. For example, DIM A$(10) allocates 10 characters of storage for A$. Once you have created a string in this way, you can refer to portions of it directly: A$[5:7] indicates the substring from position 5 to position 7.

If you are translating from a version of BASIC with dynamic string allocation to one with preallocation or vice versa, you'll probably need to change every string reference in the program.

Character coding is another problem area related to strings. Some computers use ASCII (American National Standard Code for Information Interchange) for coding characters; some do not. The functions CHR$, ASC, and NUM all deal with character coding. If the original program uses any of these functions, you'll need to check that your computer uses a compatible

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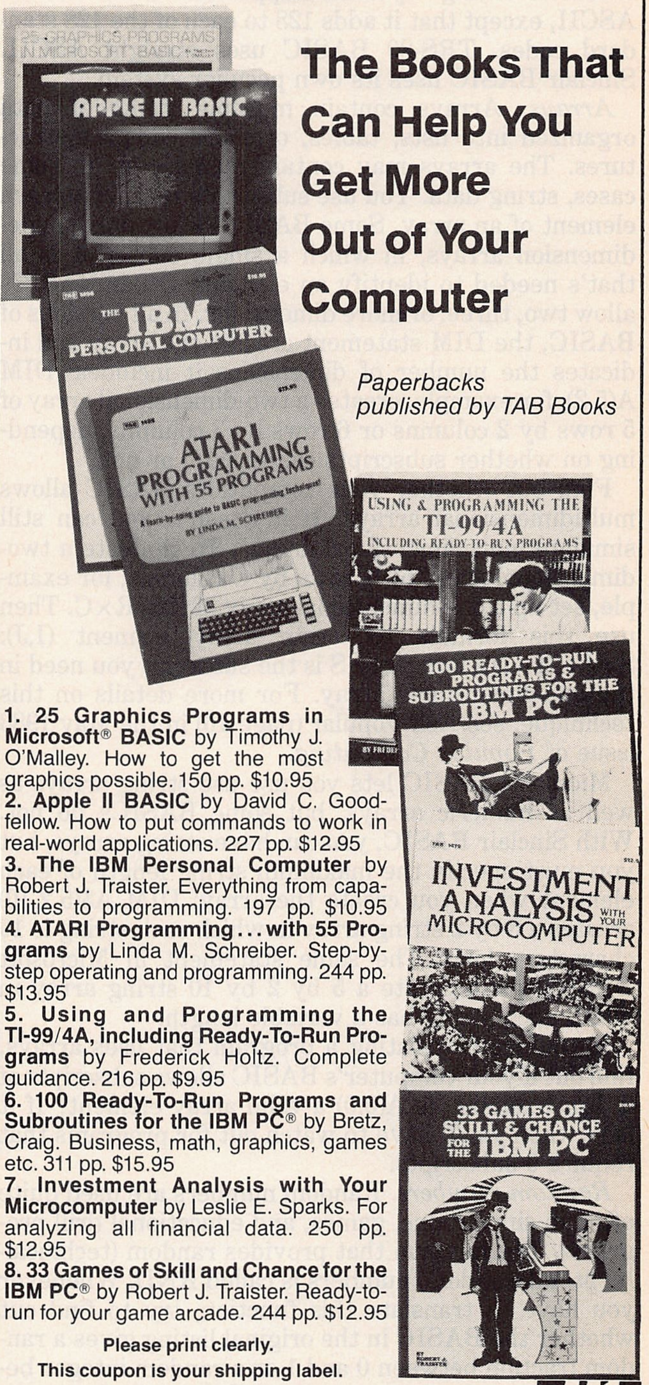

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character-coding system. Applesoft BASIC uses ASCII, except that it adds 128 to each of the 128 standard codes. TRS-80 BASIC uses straight ASCII. Sinclair BASIC uses its own peculiar system.

Arrays. Arrays contain multiple items of data organized into lists, tables, or more complex structures. The arrays may contain numeric or, in some cases, string data. You use subscripts to refer to each element of an array. Some BASICs allow only single-dimension arrays, in which a single subscript is all that's needed to identify an element. Other BASICs allow two, three, or more dimensions. In all versions of BASIC, the DIM statement creates the array and indicates the number of dimensions it includes. DIM A(5,2), for example, creates a two-dimensional array of 5 rows by 2 columns or 6 rows by 3 columns, depending on whether subscripts can equal 0 or not.

Find out whether your computer's BASIC allows multidimensional arrays. If it doesn't, you can still simulate multidimensional arrays. To simulate a two-dimensional array of R rows by C columns, for example, set up a one-dimensional array of size $R\times C$. Then use this formula to locate array element (I,J): $S=J+((I-1)\times R)$, where S is the subscript you need in the one-dimensional array. For more details on this technique, see Ask Popular (page 16) in the May 1983 issue of *Popular Computing.*

Microsoft BASIC lets you use use string arrays as well as numeric arrays, but some BASICs do not. With Sinclair BASIC, you can have string arrays, but you must specify the maximum string length of each element when you create the array: DIM A$(5,2,10) creates a 5 by 2 string array in which each string is 10 characters long. The same statement in Microsoft BASIC would create a 5 by 2 by 10 string array in which each string has a variable length.

If you are translating a program that uses arrays, find out if your computer's BASIC allows subscripts of 0. For example, is A(0,0) a valid array element? If it isn't, then you'll have to watch out for programs that require 0 subscripts.

Random numbers. Random numbers are used quite often in simulations, games, and educational drill programs. The function that provides random (technically, pseudorandom) numbers is called RND. Whenever you have to translate this function, try to find out whether the BASIC in the original listing gives a random fraction between 0 and 1 or a random integer between 1 and some other number. Then make your computer's version of BASIC produce random numbers within the same range.

With Applesoft BASIC, HP BASIC, and many other versions, RND(1) gives a random fraction between 0 and 1. With TRS-80 BASIC and others, RND(0) does the same thing. However, with TRS-80 BASIC, RND(N) gives an integer from 1 to N when N is a positive integer.

What if you need a random number from 1 to N, but your computer can provide only random fractions from 0 to 1? The answer is simple—just use a conversion formula. If your computer uses RND(1) to get a fraction, use INT(RND(1)*N)+1. If your computer uses RND(0) to get a fraction, use INT(RND(0)*N)+1.

Display format. Display sizes vary among personal computers from 8 lines by 40 columns (TRS-80 Model 100) to 24 lines by 80 columns (typical display terminal) to 40 lines by 132 columns (Apple Lisa computer). Obviously, you may need to substantially change the PRINT statements in the original program just to get a neat appearance on your computer screen. Common sense and trial and error will help you make these changes. However, a few variants of PRINT require special attention.

Some BASICs let you position the cursor directly. For example, PRINT @ (3,30), "HI" positions the cursor at row 3, column 30 before printing the message. An alternate form used on the TRS-80 Model III is PRINT @ 210, "HI", which moves the cursor to the 210th print position, counting from the upper-left corner and moving across and down the screen from left to right repeatedly, before printing HI. You may occasionally have to translate from the row-column system to the print-position system or vice versa. The following formula should help: $P=Rw+C$ where P is the print position, R is the row position, w is the column width of the display, and C is the column position. The formula assumes that the upper-left corner of the screen is (0,0) in the row-column system and 0 in the print-position system.

Keyboard input. INPUT is the most common way of getting keyboard input when you run a program. The primary variation here is that some computers allow a prompted input:

```
10 INPUT "ENTER A NUMBER"; X
```

prints the message in quotes and then stops and waits for keyboard input. If your version of BASIC doesn't allow prompted input, use this form:

```
10 PRINT "ENTER A NUMBER? ";
12 INPUT X
```

Occasionally a program needs to check the keyboard to see if a key has been pressed without stopping and waiting. This technique is commonly used in games and simulations. The INKEY$ function is the most common way of doing this; for example:

```
10 A$=INKEY$
20 IF A$="" THEN 10
30 PRINT A$;
40 GOTO 10
```

If your version of BASIC doesn't have the INKEY$ function but a program you want to use does, you may be able to get the same result by addressing your computer's hardware directly. For example, here's the Apple II equivalent of the program just given:

Circle 8 on inquiry card.

```
10 A=PEEK(49152)
20 IF A<128 THEN 10
30 POKE 49168, 255
40 A1$=CHR$(A)
50 PRINT A1$;
```

Debugging

If you've made it this far, you've passed another milestone: you have a first draft of the translated program or at least a thoroughly marked-up revision of the original program. Now you're ready to run the program. You can be almost certain you'll uncover more problems before you finally get the program to run. But now, for the first time, your computer will be able to help you by giving you error messages like:

```
?SN ERROR IN LINE 100
```

which indicates a syntax error in line 100.

Syntax errors mean one of three things: you've made a typographical error, you've used a keyword your computer doesn't recognize, or the punctuation is incorrect. We'll assume you've eliminated the first kind of error and concentrate on the other two.

Check every keyword in the offending line. If your books tell you the keyword is okay, then it's probably a punctuation error. For example, where the original program uses a semicolon, your version of BASIC may require a comma or a colon. This kind of variation is common in PRINT and INPUT statements and also between statements on multistatement lines. (HP BASIC uses @ to separate statements; Microsoft BASIC uses a colon.)

Once you've eliminated all syntax errors, you may have to deal with a whole new swarm of run-time errors, including subscript errors, out-of-data errors, and more. Read the error messages closely and look them up in your language reference manual. Keep telling yourself your computer is trying to help you.

The debugging process may take a while. It's a subject unto itself, quite beyond the scope of this column. However, here are a few suggestions:

- Get a printout of the program so you can see the entire listing at once. This will help you in planning your debugging strategy.
- Assuming you understand the overall program logic and the function of each variable, add a few PRINT statements in strategic places to see whether key variables are taking on the correct values.
- Test the major modules of the program by inserting STOP statements after each logical block. While the computer is stopped, use PRINT to examine the contents of each variable.
- Test the subroutines by giving the variables dummy values in the immediate mode and then using GOSUB commands to execute the subroutines. Use PRINT to check the effects of the subroutines on your variables.
- If your computer has a trace function (TRON,

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TROFF, TRACE ON, and TRACE OFF are the usual commands), use it to find out if the computer is executing the lines in the correct order.

The Impossible Dream?

This is the eleventh installment of The Program Factory. Judging from letters we've received, many readers have succeeded in translating the programs to run on their computers. Those who haven't succeeded have come close. Often a minor point, such as the use of RND, has been a reader's downfall. Occasionally a misreading of the letter O for the figure 0 caused the problem. But in almost every case, the thwarted reader has been very close to having a working program. We hope the advice in this article will help that reader complete the adventure.

And to all those readers who may now attempt what before would have seemed out of the question, I hold out only one promise: you *will* learn BASIC! □

If you have questions about this article or suggestions for future projects, send them to: The Program Factory, POB 397, Hancock, NH 03449.

Useful Substitution Subroutines

According to regular readers of this department, the four Microsoft keywords that most often cause problems for would-be translators are: RND, INSTR, MID$, and STRING$. RND generates random numbers, and most computers have this function; however, the function works differently on various models. Hints for translating RND are given in the main text.

In case your computer lacks one of these other "problem" keywords and a program you want uses them, here are replacement subroutines you can try. We've provided a test program at the beginning of each subroutine for your convenience.

INSTR

This function determines whether one string (the "search string") is contained in another string (the "text"). INSTR gives the starting position of the search string within the text or 0 if the string is not found.

ZA$ contains the text, ZB$ contains the search string, ZP is the starting position for the search, and ZF is the position where the search string is found. ZJ is used for internal calculations.

```
10 INPUT "ENTER TEXT"; ZA$
20 INPUT "ENTER STRING TO FIND"; ZB$
30 INPUT "ENTER STARTING POSITION"; ZP
40 GOSUB 100
50 IF ZF=0 THEN 80
60 PRINT "FOUND AT POSITION" ZF
70 GOTO 10
80 PRINT "NOT FOUND"
90 GOTO 10
98 REM...SUBROUTINE REPLACEMENT FOR
99 REM...ZF=INSTR(ZP,ZA$,ZB$)
100 ZF=0
110 FOR ZJ=ZP TO LEN(ZA$)-LEN(ZB$)+1
120 IF ZB$ <>MID$(ZA$,ZJ,LEN(ZB$)) THEN 150
130 ZF=ZJ
140 ZJ=LEN(ZA$)-LEN(ZB$)+1
150 NEXT ZJ
160 RETURN
```

MID$

This statement is not to be confused with the MID$ function, which is available in most versions of BASIC. The MID$ statement appears on the left side of an assignment statement, as in: MID$(C$,2)="CAT", which replaces a portion of C$ starting at position 2 with the word CAT. Many versions of BASIC lack this statement.

In the subroutine below, ZA$ is the string to be modified, ZB$ is the replacement substring, ZP is the starting position for the replacement, and ZC$ is used for internal calculations.

```
10 INPUT "ENTER ORIGINAL STRING"; ZA$
20 INPUT "ENTER NEW SUBSTRING"; ZB$
30 INPUT "ENTER STARTING POSITION"; ZP
40 GOSUB 70
50 PRINT "THE NEW STRING IS " ZC$
60 GOTO 10
68 REM...SUBROUTINE REPLACEMENT FOR
69 REM...MID$(ZA$,ZP)=ZB$
70 ZC$=""
80 IF ZP=1 THEN 100
90 ZC$=LEFT$(ZA$,ZP-1)
100 ZC$=ZC$+ZB$
110 IF LEN(ZA$)-LEN(ZB$)-ZP+1=0 THEN 130
120 ZC$=ZC$+RIGHT$(ZA$,LEN(ZA$)+LEN(ZB$)-ZP+1)
130 ZA$=ZC$
140 RETURN
```

STRING$

The STRING$ function repeats a string of characters. ZC$ contains the character to be repeated, ZN is the length of the string, and ZS$ is the resultant string. ZJ is used for internal calculations.

```
10 INPUT "ENTER CHARACTER TO REPEAT"; ZC$
20 INPUT "ENTER NUMBER OF TIMES TO REPEAT"; ZN
30 GOSUB 100
40 PRINT "HERE IS THE STRING OF CHARACTERS " ZS$
50 GOTO 10
98 REM...SUBROUTINE REPLACEMENT FOR
99 REM...ZS$=STRING$(ZN,ZC$)
100 ZS$=""
110 FOR ZJ=1 TO ZN
120 ZS$=ZS$+ZC$
130 NEXT ZJ
140 RETURN
```

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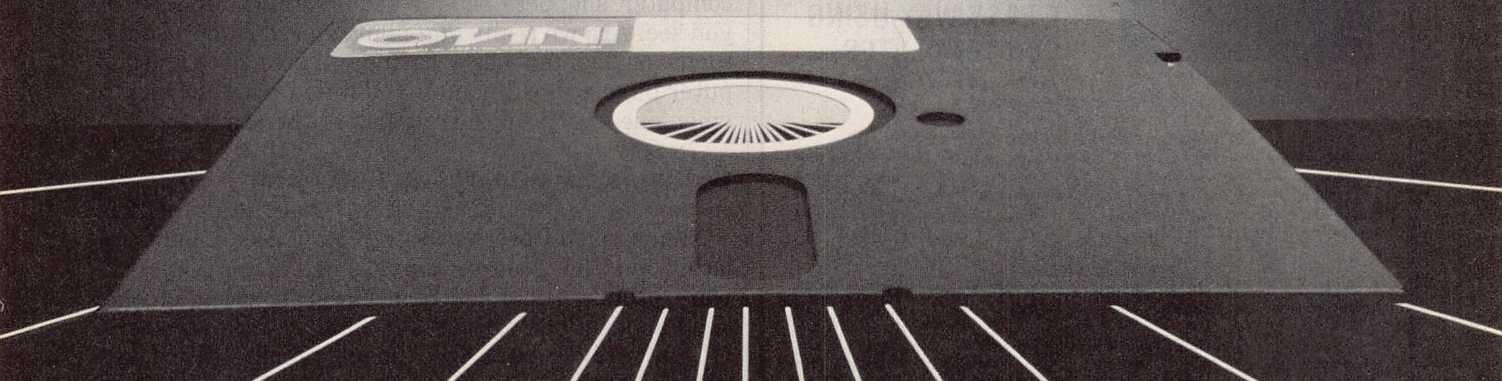

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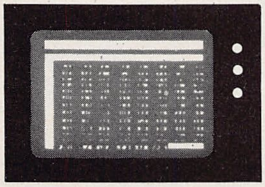

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Special Hardware Reviews

Have you noticed that the names of computers are getting more offbeat and catchy? Yes, after a glut of "Data" this and "Porta" that, we'll be reviewing some new computers with sporty handles such as Gavilan, Pied Piper, and Basis (pronounced BAH-sis) 108. The Gavilan, which gets its name from a mountain range in northern California, is a nifty portable targeted at discerning executives. The Pied Piper portable just might mesmerize you with its attractive price (under $1300) and its "bundled" CP/M software. And from West Germany, the Basis 108 gives you most of what the Apple IIe does at a comparable price—and therein lies its uphill marketing battle. Next month's hardware reviews will be as lively as these product names themselves.

Complete Guide to Statistical Software

"Lambda" and "gamma" may bring back fond memories of your college fraternity days, but they're also terms that have special significance in the field of statistics, an area of study that can be downright baffling to beginners. Next month, we'll look at what some of these specialized terms mean as we rate the software that helps you master this arcane discipline.

Sympathy for the Salesperson

Believe it or not, the person who holds your hand down at the local computer store has some pretty rough days, what with rude customers making impossible demands. Next month a southern California computer salesman/consultant turns the mirror on computer shoppers—and you may recoil from what you see. Are we really *that* ill-mannered and presumptuous, or do a few nasty customers give all of us computer buyers a bad name? You'll find out next month when one angry salesman takes to the soapbox.

Software for Integrating Software

A new software offering from Quarterdeck Office Systems called DesQ has been getting a lot of publicity lately—and for good reason: it's one of the first software products that lets you integrate other off-the-shelf applications packages from different publishers. If you've ever fantasized about running Wordstar, dBASE II, and Peachtree Accounting concurrently, dream no more. Quarterdeck's DesQ is a product that's going to put new wrinkles in the ever-changing integrated software market.

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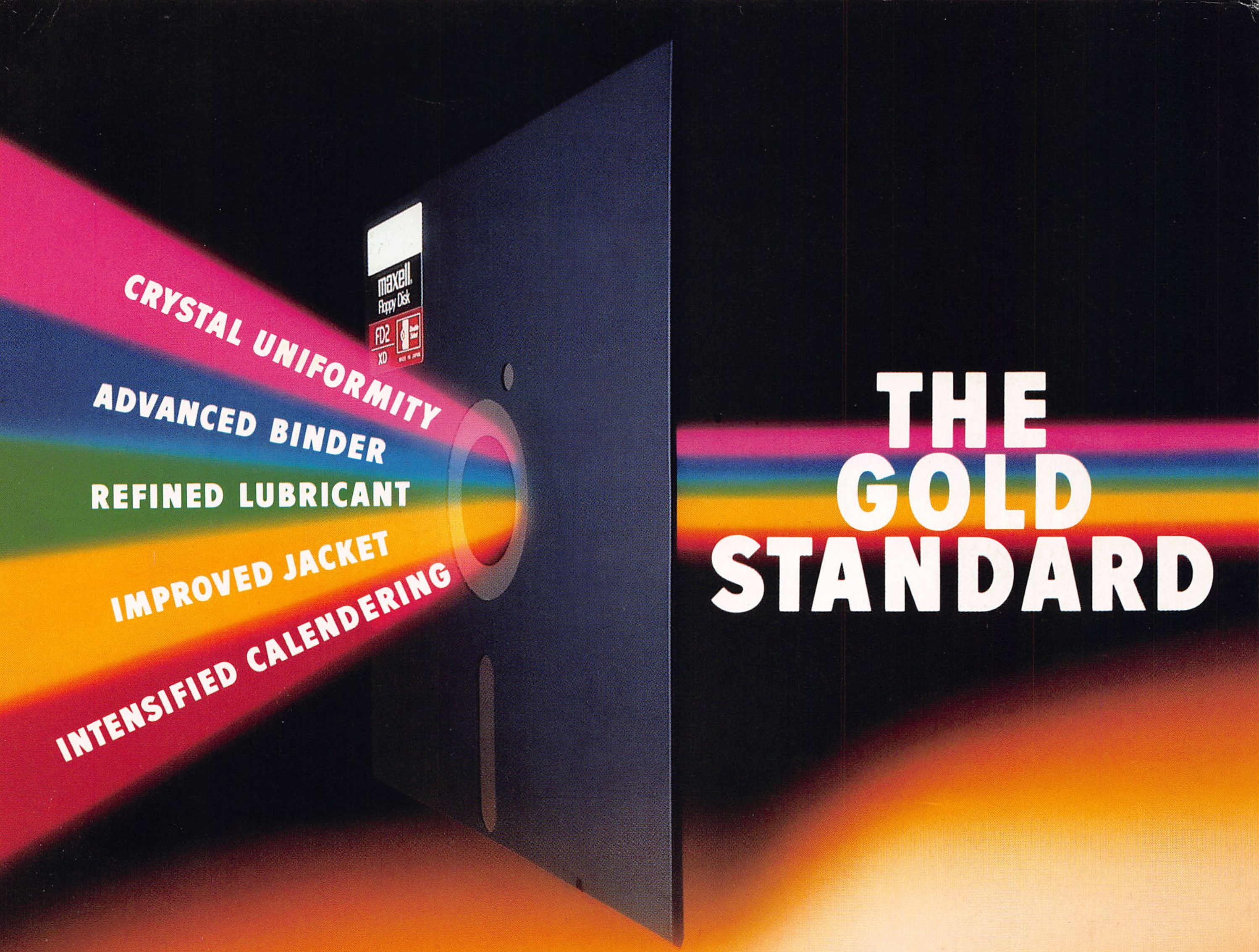
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